NCHRP

RESEARCH REPORT 939

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods

Volume 2: Construction Manager–General Contractor Delivery

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NCHRP RESEARCH REPORT 939

Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods

Volume 2: Construction Manager–General Contractor Delivery

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2020

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed, and implementable research is the most effective way to solve many problems facing state departments of transportation (DOTs) administrators and engineers. Often, highway problems are of local or regional interest and can best be studied by state DOTs individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation results in increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

Recognizing this need, the leadership of the American Association of State Highway and Transportation Officials (AASHTO) in 1962 initiated an objective national highway research program using modern scientific techniques—the National Cooperative Highway Research Program (NCHRP). NCHRP is supported on a continuing basis by funds from participating member states of AASHTO and receives the full cooperation and support of the Federal Highway Administration (FHWA), United States Department of Transportation, under Agreement No. 693JJ31950003.

The Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine was requested by AASHTO to administer the research program because of TRB's recognized objectivity and understanding of modern research practices. TRB is uniquely suited for this purpose for many reasons: TRB maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; TRB possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; TRB's relationship to the National Academies is an insurance of objectivity; and TRB maintains a full-time staff of specialists in highway transportation matters to bring the findings of research directly to those in a position to use them.

The program is developed on the basis of research needs identified by chief administrators and other staff of the highway and transportation departments, by committees of AASHTO, and by the FHWA. Topics of the highest merit are selected by the AASHTO Special Committee on Research and Innovation (R&I), and each year R&I's recommendations are proposed to the AASHTO Board of Directors and the National Academies. Research projects to address these topics are defined by NCHRP, and qualified research agencies are selected from submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Academies and TRB.

The needs for highway research are many, and NCHRP can make significant contributions to solving highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement, rather than to substitute for or duplicate, other highway research programs.

NCHRP RESEARCH REPORT 939, VOLUME 2

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FOREWORD

By Edward Harrigan
Staff Officer
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NCHRP Research Report 939 presents practical guidance for the post-award administration of projects delivered using alternative, nontraditional methods. The report will be of immediate interest to engineers in state and local transportation agencies and industry with responsibility for planning, designing, and delivering transportation projects using alternative contracting methods.

Much research and reporting has been completed in the past decade on project delivery using alternative contracting methods such as design–build, construction manager at risk, construction manager as general contractor (CM-GC), and other nontraditional methods. The bulk of this work has been accomplished with a focus on the decision process for pre-award procurement and project delivery. However, information is lacking on effective methods for administering alternative contracting method contracts after they have been awarded. Previous NCHRP research found that contract administration issues comprised most of the case law in alternative contracting methods, suggesting a need for an evaluation of current methods for post-award contract administration of design–build and CM-GC projects and the preparation of guidebooks describing the most effective methods available.

Under NCHRP Project 08-104, the University of Colorado Boulder—in association with Arizona State University and the University of Arizona—was tasked with developing practitioner guidebooks for post-award contract administration of design–build and CM-GC projects based on the identification and analysis of the methods used in the range of alternative contracting method projects. Their research entailed a review of the current state of the practice in post-award design–build and CM-GC contract administration, development of a model of the contract administration process, case studies of post-award contract administration of 19 design–build and 11 CM-GC projects, an effectiveness evaluation and calibration of tools for post-award contract administration, and testing of the draft guidebooks on ongoing and completed design–build and CM-GC projects.

The key outcomes of this research are *NCHRP Research Report 939: Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods, Volume 1: Design–Build Delivery* and *NCHRP Research Report 939: Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods, Volume 2: Construction Manager–General Contractor Delivery*. Volumes 1 and 2 also include Appendix A: Contract Administration Tools and Appendix B: Case Studies. Volume 3 is the contractor's final report, which provides results and analyses supporting the guidebooks' contents.

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Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

CHAPTER 1

Introduction

This chapter provides an overview of *NCHRP Research Report 939: Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods, Volume 2: Construction Manager–General Contractor Delivery*. It identifies the guidebook's audience and describes how agencies can select tools and strategies for their construction manager–general contractor (CM-GC) projects. For context, the chapter provides a brief history of CM-GC delivery for U.S. highway projects. It also explains the industry need for contract administration guidance, and it introduces key terms. The guidebook includes a more comprehensive glossary following References and Bibliography. After a brief explanation of the research approach, the chapter provides a list of tools that agencies can use to administer CM-GC contracts. Later chapters and Appendix A explain the tools in more detail.

1.1 Overview

This guidebook is a practitioner's guide for construction administration on CM-GC projects. Whether your agency is using the CM-GC contracting method for the first time or has significant experience with the method, this guidebook provides useful strategies and tools to support CM-GC project administration. Highway agency personnel are the audience for the guidebook. As an AASHTO publication, the guidance must apply at a national level. Each agency will need to adapt the strategies and tools to their unique agency policies and practices.

This guidebook will help agencies incorporate contract administration into their CM-GC procedures manuals.

1.2 Construction Manager–General Contractor Background

The use of alternative contracting methods has accelerated the delivery of highway design and construction projects. These changes have come through the innovative efforts of FHWA and state agencies around the country over the last 30 years. Led by documented successes on large, high-profile projects such as I-15 in Utah, the Intercounty Connector in Maryland, and the Sellwood Bridge in Oregon (Sellwood Bridge Project 2017), alternative contracting methods have resulted in shorter project delivery times with less disruption to the traveling public.

The CM-GC method is the newest of the alternative contracting methods, and it may show the most promise for accelerating delivery times while reducing project risk for the agency and the contractor. Section 1303 of the Moving Ahead for Progress in the 21st Century Act (MAP-21) fully authorizes the use of CM-GC for federally funded transportation projects. FHWA published a final rule for CM-GC contracting on December 2, 2016 (Federal Register

2016). Of all the alternative contracting methods in use by highway agencies, CM-GC has seen perhaps the most rapid growth since 2012.

1.3 Industry Need for a Guidebook

The innovative efforts of the highway agencies should not be underestimated. The CM-GC contracting process requires significant procedural and cultural changes.

The CM-GC contracting process requires significant procedural and cultural changes on the part of agency staff. Agencies are developing manuals on procurement guidance for these delivery methods. However, a review of current alternative contracting methods manuals reveals the existence of only a few manuals addressing contract administration processes. AASHTO's *A Guidebook for CM/GC Contracting for Highway Projects* (Gransberg et al. 2013) and *NCHRP Synthesis 402: Construction Manager-at-Risk Project Delivery for Highway Programs* (Gransberg and Shane 2010) primarily focus on the pre-award phases of the method.

This guidebook specifically addresses the post-award phase. It provides effective tools for the post-award contract administration of CM-GC projects.

1.4 Key Guidebook Terms

This section provides a short list of key guidebook terms. A more comprehensive glossary follows References and Bibliography.

Alternative Contracting Method (ACM): The traditional contracting method is design–bid–build (D-B-B). Alternative contracting methods include design–build (D-B), construction manager–general contractor (CM-GC), and alternative technical concepts (ATC). Other synonymous terms are innovative contracting method and alternative project delivery method.

Construction Manager–General Contractor (CM-GC): A contract between an owner and a construction manager who will be at risk for the final cost and time of construction. In this agreement, the owner authorizes the construction manager to provide input during project design. It may consist of two separate contracts: preconstruction services and construction (Gransberg and Shane 2010).

Design–Bid–Build (D-B-B): The traditional project delivery method for building highways and making highway improvements where the agency (or a consulting engineer working for the department) designs the project, solicits bids, and awards the construction contract to the lowest responsive bidder (construction contractor) to build the project (Molenaar et al. 2005).

Strategy: A plan of action for accomplishing specific goals. In this guidebook, strategies address goals relating to CM-GC administration, such as team alignment, construction quality, or construction efficiency.

Tool: A tool is used to perform an operation. In this guidebook, it is a tactic or process—such as checklists, spreadsheets, guidelines, and structured meetings—relating to CM-GC contract administration.

1.5 Guidebook Development

This practitioner's guidebook is based on CM-GC contract administration practices used by a wide cross section of transportation agencies. It was developed through a review of current literature and agency manuals, case studies, and interviews with agency personnel.

More than 100 practitioners contributed to this guidebook in the case studies, tool validation and calibration, and guidebook testing.

A brief summary of the research follows. The corresponding research report provides a detailed description of the work.

State-of-practice reviews—Thirty-one transportation agencies' alternative contracting methods manuals and documents relevant to post-award alternative contracting methods contract administration identified contract administration tools for CM-GC contract administration.

Process model development—A detailed process model of the CM-GC contract administration process was developed to aid in data collection and guidebook layout. The process model revealed the CM-GC contract administration phases of Alignment, Design, Preconstruction Services, Construction, and Closeout.

Project case studies—A diverse set of 11 CM-GC projects were the subject of case study interviews. The team interviewed every state Department of Transportation (DOT) that had an active CM-GC highway project at the time of the research and worked with these state DOTs to gather data on their projects. About half of the projects had a total project cost greater than $50 million (including design, preconstruction services, and construction), while the other half were between $10 million and $50 million. No CM-GC highway projects that cost less than $10 million were identified during preparation of the guidebook.

Tool effectiveness evaluation and calibration—Thirty-two tools appropriate to CM-GC contract administration were identified through the case studies and state-of-practice reviews. A modified Delphi approach was used to calibrate the effectiveness corresponding to project size, level of complexity, and phase of contract administration.

Guidebook development and testing—In addition to a thorough NCHRP panel review, the research team met with agencies from across the country to test the guidebook on ongoing and completed CM-GC projects.

1.6 Overview of Post-Award Project Phases and Tools

The CM-GC project delivery process offers the opportunity for enhanced performance in areas such as cost, schedule, and quality through early contractor involvement. The CM-GC process maintains the contractual separation of engineering consultant and constructor. However, agencies involve the CM-GC throughout the design process to infuse construction knowledge, means, and methods into the design. The first phase of the CM-GC process involves a contract for preconstruction services. When enough of the design is complete and a construction price is agreed upon, the team will complete the first construction work package. Agencies use a range of construction payment methods, including lump sum by milestone or payment of items with unit price from actual field measurements.

Agencies involve the CM-GC throughout the design process to infuse construction knowledge, means, and methods into design.

Agencies design CM-GC projects in house or through a consultant contract. Including a construction manager during the design process and the potential use of multiple construction work packages make the CM-GC contract administration processes different from D-B-B.

Process modeling for this guidebook revealed that CM-GC contract administration processes vary from agency to agency and even within agencies. However, key CM-GC processes were found on all projects across agencies. CM-GC projects proceed through five overlapping phases from the agency's perspective of project administration:

- Alignment,
- Design,

- Preconstruction Services,
- Construction, and
- Project Closeout.

There are three key distinctions of CM-GC contracting when comparing it to a traditional D-B-B contract administration:

- Involvement of the construction manager in design for risk mitigation and constructability input,
- Integration of an independent cost estimator to assist in reaching a guaranteed maximum price or construction agreed-upon price, and
- Use of multiple contract work packages to expedite construction.

Agencies have developed a number of tools to accomplish the administrative tasks in these five phases and with these three key distinctions. Table 1.1 lists the tools and describes the phases for use. Chapters 4 through 8 describe the application of these tools across the five phases.

Tools for agency contract administration vary depending on the phase of project development, the specific task, project complexity, and project size. Objectives and tasks change across phases, as do the tools used for contract administration. Agencies apply some tools during one phase only and apply others across multiple phases.

It is not necessary to use all of the tools in this guidebook to have a successful project. Tool selection should consider project goals, complexity, size, and phase.

Chapters 4 through 8 detail the effectiveness of tools across various levels of complexity, size, and phase. Appendix A provides full information about each tool with advice for application and examples from the agency case studies.

1.7 Reader's Guide

The target audience for this guidebook is state transportation agency personnel. The guidebook contains information for agency leaders, CM-GC project managers, and technical staff. Consultants, engineers, and contractors will also benefit from the guidebook because it allows them to understand their roles and responsibilities in the process and to offer the right tools for their projects. The guidebook will assist agencies with achieving the cost and time savings that MAP-21 and the Fixing America's Surface Transportation Act envision through the use of CM-GC.

A Strategic Perspective for Agency Leaders

Agency leaders must commit to transforming organizational culture, mentoring individual behavior, and developing procedures for alternative contracting methods.

To maximize the benefits of CM-GC contract administration tools, the guidebook suggests five overarching contract administration strategies: Alignment, Scope, Preconstruction Services Quality, Construction Quality, and Construction Efficiency. Chapter 2 discusses these strategies in detail. Agency leadership is the primary audience for this chapter. Strategies support the use of the tools in this guidebook and the creation of new, agency-specific tools.

Moreover, agency leaders must be aware of and commit to transforming organizational culture, mentoring individual behavior, and developing procedures for alternative contracting methods. Agencies that are effective at modifying their culture and procedures specific to CM-GC contract administration will ensure the integration of strategies and tools in all project phases. For example, agency leadership must support a close

Table 1.1. Construction manager–general contractor contract administration tools.

Tools for Construction Manager–General Contractor Contract Administration	Contract Administration Phases				
	Alignment	Design	Preconstruction	Construction	Closeout
1 Kickoff Meeting	✓				
2 Roles and Responsibilities	✓				
3 Glossary of Terms	✓				
4 External Stakeholder Coordination Plan	✓	✓			
5 Regulatory Agency Partnering	✓	✓	✓		
6 Co-Location of Key Personnel	✓	✓	✓		
7 Construction Manager–General Contractor Management Fee Table	✓		✓	✓	✓
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓
9 Continuity of Team Members	✓	✓	✓	✓	✓
10 FHWA Involvement Overview	✓	✓	✓	✓	✓
11 Permit Commitment Database	✓	✓	✓	✓	✓
12 Discipline Task Force		✓			
13 Independent Party Design Review		✓			
14 Plan Standards		✓	✓		
15 In-Progress Design Workshops		✓	✓		
16 Deviations from Agency Standards		✓	✓		
17 Over-the-Shoulder Reviews		✓	✓		
18 Open-Book Estimating			✓	✓	
19 Public Announcements		✓	✓	✓	✓
20 Delegation of Authority		✓	✓	✓	✓
21 Cost-Comparison Spreadsheet			✓		
22 Cost-Modeling Approach			✓		
23 Construction Manager–General Contractor Bid Validation			✓		
24 Independent Cost Estimator			✓		
25 Cost–Savings Matrix			✓		
26 Opinion of Probable Construction Cost Process			✓		
27 Risk Pools			✓	✓	
28 Contractor-Controlled Quality Control Testing				✓	
29 Contractor Involvement in Establishing Quality Control Standards				✓	
30 Real-Time Electronic Quality Management Information				✓	
31 Witness and Hold Points				✓	
32 Payment Checklist				✓	✓

working relationship between the construction manager, engineer, and independent cost estimator. This is a significant change in culture from the traditional D-B-B contracting method, which intentionally separates these parties.

The application of CM-GC contracting impacts agency culture in all phases of contract administration. Agency leadership can support this change through the application of the strategies and tools found in this guidebook.

Guidebook Organization

Chapter 2 describes overarching management strategies that help categorize and recommend tools for use in CM-GC contract administration within an agency. Chapter 3 discusses

This guidebook should be used in conjunction with AASHTO's *Guidebook for CM/GC Contracting for Highway Projects* and *NCHRP Research Report 939: Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods, Volume 1: Design–Build Delivery.*

the CM-GC process at the pre-award phase and touches on key topics, such as the reasons why agencies select CM-GC and how much design they complete prior to CM-GC involvement. Chapters 4 through 8 are the heart of this guidebook. Each of these chapters introduces one of the five post-award phases and briefly describes the tools available in that phase. These chapters help to clarify an agency's role in administering alignment, design, preconstruction, construction, and closeout. Chapter 9 describes the steps that agencies can take to implement the strategies and tools in this guidebook. It also provides guidance on performance measures and continuous improvement. Finally, Appendix A provides details of each tool identified in a consistent format, along with descriptions and successful examples from various agencies.

Finally, readers should be aware of two companions to this guidebook. AASHTO's *A Guidebook for CM/GC Contracting for Highway Projects* (Gransberg et al. 2013) emphasizes setting projects up for success by focusing on the pre-award phases of the process. It serves as an excellent precursor to this guidebook. As part of the research for this CM-GC guidebook, the research team also developed *NCHRP Research Report 939: Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods, Volume 1: Design–Build Delivery.* While the organizational and administration processes differ between CM-GC and D-B, many of the strategies and tools overlap.

CHAPTER 2

Overarching Contract Administration Strategies

2.1 Introduction

This chapter introduces overarching strategies that will aid in successful CM-GC contract administration. A comprehensive examination of the 35 tools in this guidebook, content analysis of agency alternative contracting methods manuals, and themes from the case studies reveals higher-level strategies for CM-GC contract administration success. Five overarching CM-GC contract administration strategies will assist with the implementation of the existing tools, the creation or addition of new contract administration tools, and, ultimately, the successful administration of CM-GC projects.


ALIGNMENT

Alignment Strategy—Establish clear project goals, and create productive relationships within the agency, as well as between the agency and CM-GC team members.


SCOPE

Scope Strategy—Ensure that the project scope and responsibilities are understood and agreed upon by all parties.


PRECONSTRUCTION QUALITY

Preconstruction Services Quality Strategy—Ensure quality of preconstruction services through active participation in design reviews and through verification of competitive pricing of estimates.


CONSTRUCTION QUALITY

Construction Quality Strategy—Promote quality during construction, and enforce the requirements of the CM-GC contract.


CONSTRUCTION EFFICIENCY

Construction Efficiency Strategy—Implement a system that increases efficiency during construction and aligns with roles and contractual responsibilities.

The following sections describe the strategies in more detail and discuss how agency leadership can implement them across programs and within projects. Strategy icons throughout the guidebook—particularly in the tools appendix—highlight the tools and recommendations that relate to the strategies.

2.2 Alignment Strategy


ALIGNMENT

Establish clear project goals, and create productive relationships within the agency, as well as between the agency and CM-GC team members. A key element to construction administration project success begins with clear communication and purposeful alignment between team members during the early stages of the project, right after procurement. Better alignment and integration between project stakeholders correlates with better project performance on a variety of metrics and in diverse sectors, including transportation.

Developing effective lines of communication and working on agency–engineer–contractor relationships early on will set positive behavioral expectations for the duration of the project. Delaying stakeholder alignment may allow the project team to revert to traditional D-B-B roles and behaviors where there is a purposeful and legal separation between these parties. The CM-GC contracting methods require intense collaboration. Agencies must align these parties from the onset of the contract.

Agencies should establish project goals when selecting the CM-GC method (see Chapter 3, Project Goals). Project managers must emphasize these project goals with the engineer and CM/GC team throughout all project phases, beginning with the 1 Kickoff Meeting.

To ensure success, teams should consult the project goals during critical design, risk allocation, scheduling, and pricing decisions.

Co-location of key personnel can help to expedite decisions and the overall design and construction process.

The CM-GC contracting method maintains the legal separation of design and construction entities, but roles and responsibilities can change. The use of 2 Roles and Responsibilities can clarify team member functions and help to avoid problems. The use of 6 Co-Location of Key Personnel can help to expedite decisions and the overall design and construction process.

The use of CM-GC encourages partnering by assembling the team early and establishing relationships and communications protocols before the project activities ramp up, as in 8 CM-GC–Specific Partnering. This partnering can be either informal—occurring organically with team formation and normal interactions—or formal, with facilitated meetings producing a team charter in alignment with project goals and using an evaluation plan.

On major projects, using formal partnering with a formal evaluation plan is an effective alignment strategy.

Project teams should also realize that alignment extends beyond the core project team. The team must also align key stakeholders, especially those who might not be familiar with the team integration or pace of a CM-GC project. Project teams can apply tools such as 4 External Stakeholder Coordination Plan, 5 Regulatory Agency Partnering, and 10 FHWA Involvement Overview to maximize alignment with external stakeholders.

2.3 Scope Strategy


SCOPE

Ensure that the project scope and responsibilities are understood and agreed upon by all parties. A clear understanding of the project scope is essential for successful execution of a CM-GC project. The Alignment Strategy discussed earlier is a foundation to allow for a successful Scope Strategy because it helps align all key stakeholders around the scope of the project.

The CM-GC process involves the contractor early in design. This is beneficial for constructability reviews and overall team alignment on the project scope. However, there is a risk that this early involvement can lead to scope growth if all team members do not fully understand the limits of the project scope. Some agencies use 27 Risk Pools—or another similar tool—to help balance

risk and scope growth. Project teams must identify any discrepancies in team understanding of scope or areas of uncertainty as soon as possible to avoid delays or cost growth.

> The highly integrated and fast-paced nature of CM-GC contracting requires a stable group of core team members to maintain scope and budget control.

9 Continuity of Team Members describes a key lesson learned from the research case studies. The highly integrated and fast-paced nature of CM-GC contracting requires a stable group of core team members. Teams can also gain beneficial scope management through the use of 13 Independent Party Design Review, as long as the design reviewers have a clear grasp of the original project scope.

Many contractors and agency team members are knowledgeable about their responsibilities within the traditional method. However, some of these responsibilities change for a CM-GC project. These include preconstruction services, discussed in the next section in the context of ensuring preconstruction services quality. Among the tools that support the Scope Strategy are 2 Roles and Responsibilities and 10 FHWA Involvement Overview.

2.4 Preconstruction Services Quality Strategy


PRECONSTRUCTION QUALITY

Ensure quality of preconstruction services through active participation in design reviews and through verification of competitive pricing of estimates. Unlike with traditional D-B-B projects, in a CM-GC project the agency hires the contractor before or during the design phase of the project to provide services prior to the start of construction. The CM-GC provides design input in the form of plans and continuously updates project costs and schedule estimates as the design progresses.

CM-GC design reviews—for example through the use of 15 In-Progress Design Workshops*—ensure constructability of the design and adherence to the project budget and schedule.*

The CM-GC involvement in the preconstruction phase also allows the agency to verify the project cost through a better understanding of project risks. Since the procurement of the CM-GC firm typically focuses on qualifications rather than on final pricing, it is important for the agency to ensure that estimates are accurate and competitive prior to acceptance of a construction agreed-upon price or a guaranteed maximum price (GMP). Therefore, the Preconstruction Services Quality Strategy should place a strong emphasis on project cost. Multiple tools are available to support this strategy, including 18 Open-Book Estimating, 21 Cost-Comparison Spreadsheet, 22 Cost-Modeling Approach, 23 CM-GC Bid Validation, 24 Independent Cost Estimator, and/or 25 Cost–Savings Matrix.

Effective preconstruction services should begin with a good definition or description of the agency's expectations, including the range of services and the degree or extent of each of the services required. For example, every preconstruction contract will require cost-estimating services. However, the extent of those services can vary widely. Is the agency expecting checkpoint cost validation at 30 percent design, 60 percent design, and 90 percent design? Or, is the agency expecting continuous, open-book cost estimation? If these items are not clear in the request for qualifications (RFQ), the agency should set these expectations at the beginning of the preconstruction phase.

2.5 Construction Quality Strategy


CONSTRUCTION QUALITY

Promote quality during construction, and enforce the requirements of the CM-GC contract. CM-GC contracts are often selected for their potential time and cost savings, but it is important that project quality remains excellent. All quality assurance (QA) and QC methods that apply to D-B-B projects apply to CM-GC projects. Additionally, the CM-GC contracting approach provides agencies with opportunities to implement alternative QA-QC methods that align with project goals.

Because of the contractors' knowledge of design, materials, and methods in the CM-GC process, agencies are more apt to involve them in QC activities.

The primary difference between CM-GC and traditional D-B-B construction quality approaches occurs in the roles and responsibilities for QA-QC. Because the CM-GC process involves the contractor early and provides an opportunity for specifying construction means and methods, agencies can request that the CM-GC firm be responsible for major QC activities. Tools to support the Construction Quality Strategy can include 28 Contractor-Controlled QC Testing and 29 Contractor Involvement in Establishing QC Standards.

The CM-GC process allows for alternative approaches to D-B-B to ensure the achievement of existing requirements and specifications. If the agency desires, it allows for a focus on superior quality during the construction phase.

2.6 Construction Efficiency Strategy


CONSTRUCTION EFFICIENCY

Implement a system that increases efficiency during construction and aligns with roles and contractual responsibilities. The CM-GC contracting method provides strong potential for time and cost savings. Achievement of this potential depends on efficient construction operations.

The Construction Efficiency Strategy is dependent on clear project goals being set during procurement (see Chapter 3, Project Goals) and quality preconstruction services being applied. In other words, construction efficiencies are made possible by the CM-GC aligning with other team members during design, gaining a clear understanding of project scope, and providing quality preconstruction services that result in a clear allocation of risks and an accurate estimate of price.

The CM-GC can also adapt to the design and be ready for the construction phase ahead of time by planning earlier than they typically can in a traditional D-B-B delivery. For example, a temporary traffic control plan is vital to project safety. CM-GC offers a tremendous advantage because the contractor can design the plan with interaction and input from the agency and allocate the necessary resources to ensure a high level of worker and motorist safety. Although this activity is similar in D-B-B and CM-GC, the timing of it makes a big difference. CM-GC offers these types of opportunities to improve construction performance and efficiency.

CM-GC also offers opportunities for a more efficient construction closeout phase to transition from construction to operations and to ensure a safe and efficient startup of the new facility. Examples of CM-GC tools to support the Construction Efficiency Strategy can include 30 Real-Time Electronic QM Information and 32 Payment Checklist.

2.7 Summary

Agencies can use these five CM-GC strategies to select tools that will help to achieve the project's goals. Agencies can assess the strategies to select tools from within this guidebook, adapt them for project-specific use, and develop new tools to fit agency-specific needs. An important aspect of developing CM-GC project tools is to identify differences from D-B-B projects and determine how to leverage these differences to lead a more successful project. By emphasizing Alignment, Scope, Preconstruction Services Quality, Construction Quality, and Construction Efficiency strategies, agency leadership can guide the project stakeholders toward CM-GC contract administration success. To facilitate this task, each of the tools in Appendix A have icons corresponding to the strategy or strategies that the tool addresses.

CHAPTER 3

Pre-Award Phase Administration

3.1 Introduction

This chapter introduces the pre-award phase and its underlying principles, which will help establish a foundation for the administration of the CM-GC contract. This guidebook focuses on post-award processes and tools for CM-GC contract administration. However, AASHTO's *A Guidebook for CM/GC Contracting for Highway Projects* (Gransberg et al. 2013) describes CM-GC procurement activities in detail. This chapter highlights some of the key project delivery and procurement decisions that lay the foundation for effective contract administration. These include

- Project goals,
- Project delivery selection,
- Engineering consultant procurement,
- Independent cost estimator procurement, and
- CM-GC procurement.

3.2 Construction Manager–General Contractor Procurement Activities that Affect Contract Administration

FHWA CM-GC regulations give state DOTs wide discretion in identifying CM-GC projects (FHWA 2016). However, at the time of this guidebook's publication, state DOTs were primarily using CM-GC for more complex projects of more than $10 million in value (FHWA 2017a). Agencies choose CM-GC when the project goals align with the advantages of this delivery method. Given that state DOTs contract the engineer and the CM-GC early in project design, procurement activities affect construction administration processes. This section of the guidebook addresses a few key concepts from the CM-GC procurement stage that are important for a successful project.

Project Goals

CM-GC project delivery can provide advantages over D-B-B project delivery. These potential advantages can include shorter project durations, earlier schedule certainty, lower initial costs, earlier cost certainty, and better life-cycle solutions. However, these advantages all assume the agency has selected an appropriate project and has clearly defined its project goals. Clearly written project goal statements, which are included in the RFQs for the CM-GC and engineering consultant (if the agency chooses to use one),

> Agencies will only realize CM-GC advantages if they clearly define project goals that align CM-GC advantages and choose appropriate projects.

are among the most important factors for CM-GC project success. They help guide the contract administration process. Table 3.1 provides example project goal statements that have been adapted from the *AASHTO Guide for Design–Build Procurement* (AASHTO 2008b).

Agencies should consistently refer to the project goals throughout all phases of the project. To help integrate the project goals into the contract administration phase, the agencies can explicitly include them in the 1 Kickoff Meeting, 4 External Stakeholder Coordination Plan, and 8 CM-GC–Specific Partnering tools.

Project Delivery Selection

With a clear understanding of project goals in mind, agencies can select the most appropriate project delivery method. Some agencies provide criteria for project selection in their alternative contracting method guidebooks based on project goals, project constraints, and legislative authority (Colorado Department of Transportation 2014, Washington State Department of Transportation 2016). Others make the decision on a case-by-case basis.

> *To properly administer a project during the construction phase, agencies should be clear as to why they select CM-GC.*

FHWA *Next Generation Transportation Construction Management Pooled Fund* study (University of Colorado Boulder n.d.) developed a project delivery matrix to facilitate the project delivery selection process. The selection matrix was promoted by FHWA in the Every Day Counts initiative (FHWA 2017b). The process promotes a project delivery workshop that is up to 1 day long. The workshop gathers key project personnel to discuss the opportunities and obstacles of each delivery method around eight critical project issues. These issues are important for both project delivery selection and construction administration.

- Delivery schedule—The overall project schedule from scope through design, construction, and opening to the public.
- Project complexity and innovation—The need for applicability of new designs or processes to resolve complex and technical issues.
- Level of design—The percentage of design completed at the time of the project delivery procurement.
- Initial project risk assessment—The process of quantifying the preliminary risk events to ensure the selection of a delivery method that properly addresses them.
- Cost—The financial process related to meeting budget restrictions, ensuring accuracy of cost estimation and controlling project costs.

Table 3.1. Mapping of construction manager–general contractor benefits to project goals.

Possible CM-GC Benefits	Project Goals
Schedule • Shorter duration • Earlier schedule certainty	Schedule • Minimize project delivery time • Complete the project on schedule
Cost • Initial cost savings • Earlier cost certainty • Less cost growth	Cost • Minimize project cost • Maximize project budget • Complete the project on budget
Quality • Equal or better quality • Quality in procurement	Quality • Meet or exceed project requirements • Select the best team
Innovation • Better constructability • Less impact on the traveling public	Innovation • Provide innovative solutions • Minimize impact on the traveling public

- Staff experience and availability—The experience and availability of the owner's staff to execute the project delivery methods under consideration.
- Level of oversight and control—The level of and manner in which the owner exercises control over design and construction processes.
- Competition and contractor experience—The level of competition, experience, and availability in the marketplace and its capacity for the project.

Evaluating these issues will allow the selection of appropriate strategies and tools for agency contract administration.

Engineering Consultant Procurement

In CM-GC, engineering design can be done by the state DOT or through an engineering consultant. Engineering consultants are more common because schedule reduction is frequently an overriding project goal on CM-GC projects. The CM-GC contracting method requires a different skill set and level of effort from engineering consultants because they will be working very closely with the CM-GC. In fact, the engineering consultant is frequently co-located with the CM-GC.

The CM-GC contracting method requires a different skill set and level of effort from engineering consultants because they will be working very closely with the CM-GC.

Engineering consultants are most commonly procured before the CM-GC. Ideally, a state DOT will include a description of the CM-GC services in the engineering consultant request for proposal (RFP). At a minimum, state DOTs should state that the project will employ CM-GC project delivery. If a project changes from D-B-B to CM-GC delivery, it is important for the state DOT to adjust the engineering consultant's scope of services to accommodate work with the CM-GC during the preconstruction and construction administration stages.

To assist engineering consultants with understanding the full scope of their services, agencies can share the CM-GC scope of services. A few contract administration tools can aid in this discussion. 2 Roles and Responsibilities will show how engineering services and CM-GC services align. 6 Co-Location of Key Personnel will reveal agency expectations for the level of team integration efforts. If the team is working in an open-book pricing environment, 7 CM-GC Management Fee Table will explicitly show where the CM-GC is interfacing with design efforts.

Independent Cost Estimator Procurement

Involvement of the CM-GC in design development necessitates the negotiation of GMP as opposed to a bidding of unit prices. Agencies can employ 25 Independent Cost Estimator to facilitate this negotiation. The independent cost estimator develops an estimate to compare against the contractor price to ensure that the agency receives a fair market value for their project.

While the cost of an independent cost estimator is far less than an engineering consultant or construction manager, independent cost estimator selection and procurement of services is critical to team integration, roles, and responsibilities during contract administration.

The agency uses an independent estimate to aid in negotiating GMP with the CM-GC. During the GMP negotiation, most agencies have some version of a variance review to compare the independent cost estimator, CM-GC, and engineering estimate. The discussion of variance revolves around all bid items that differ by more than a predefined value, typically 5 percent to 10 percent. Some of the agencies use the independent cost estimator's estimate but do not request involvement of the independent cost estimator during any of the negotiations. Others request the assistance of the independent cost estimator in estimate reconciliation. This bid reconciliation is iterative. In the event that a GMP cannot be reached, the agency has the

ability to either put the job out to bid or negotiate with the second-most-qualified CM-GC, as determined.

A clear knowledge of the CM-GC's 2 Roles and Responsibilities during construction is key to proper contract negotiation. At a minimum, agencies employ the independent cost estimator with involvement in the bid reconciliation process, which can use 21 Cost-Comparison Spreadsheet. This process must be clearly defined in the procurement documents of all parties (i.e., the independent cost estimator, engineering consultant, and CM-GC). Agencies can also include additional tasks in the independent cost estimator agreement. These most commonly include design, constructability, and schedule input. They can also include negotiating change orders and documenting lessons learned. Clarity of the independent cost estimator's scope in the CM-GC process is key to negotiating a CM-GC construction contract.

Construction Manager–General Contractor Procurement

Agencies procure CM-GCs early in the project to aid with design development. There are two phases to the CM-GC contract: preconstruction engineering services and construction. The CM-GC is selected for preconstruction services through a qualifications-based selection or best-value process, due to the undeveloped nature of the design at the time of selection. When the design has come to a point where quantities are known at a sufficient level for accurate estimates, the contractor and agency agree on a price for construction.

Qualifications-based selection and best-value selection highlight different CM/GC team and project characteristics. Qualifications-based selection procurement involves a review of the CM-GC's statement of qualifications proposal, which may include specialized qualifications, firm experience, past performance, key personnel, and project innovations. It includes no evaluation of monetary elements for construction. Best value includes cost as a scoring criterion, in addition to the qualifications proposal in the qualifications-based selection process. Best-value procurement can be a one-step RFP response or a two-step RFQ and RFP response and review.

Agencies must include and monitor any best value selection criteria in the contract administration process.

Best value procurement has an obvious impact on CM-GC project administration. Agencies must include and monitor any best value selection criteria in the contract administration process. Examples could include commitments made by the CM-GC in the procurement stage to include specific personnel or processes. The 2 Roles and Responsibilities, 7 CM-GC Management Fee Table, and 9 Continuity of Team Members tools can assist with this process. These commitments are particularly important when they include a monetary value, such as fee or unit price proposals.

3.3 Summary

Actions and decisions made by the agency during pre-award can influence the contract administration post award. Defining project goals, criteria used in selecting a delivery method, and criteria used in the selection of a CM-GC entity impact the CM-GC contract and the expectations for the project. One of the key pre-award activities is procuring an independent cost estimator and defining the approach for establishing a construction agreed-upon price or guaranteed maximum price. Thus, the pre-award phase serves to establish the foundation for administration of a CM-GC contract.

CHAPTER 4

Alignment Phase Administration

4.1 Introduction

This chapter is to discuss the alignment phase and to present tools that contribute to team alignment. This chapter addresses:

- CM-GC alignment process overview and
- Alignment phase contract administration tools.

Agencies should strive for team alignment throughout the entire project, but the alignment phase is especially critical in establishing a strong foundation. In this phase, agencies foster an environment of team integration and group cohesion to facilitate successful project delivery. Alignment is sought on every aspect of the project, including goals, scope, processes, and communication. Construction projects bring together a variety of individuals and organizations to achieve a common goal. The CM-GC process allows the agency, engineer, and contractor to work as an integrated team to complete design and construction.

4.2 Construction Manager–General Contractor Contract Administration Process

How the team—the agency, engineer, CM-GC, and project stakeholders—move from the procurement phase to the construction phase is critical to project success. Generally, the agency holds kickoff and team alignment meetings to discuss and formalize the payment schedule, work package execution flow, communication plan, organizational structure, and roles and responsibilities. For CM-GC, alignment will continue to occur while the project plans advance from the conceptual to the preliminary engineering stage and will involve team integration of the agency, contractor, and engineer. Key activities for the alignment phase include:

- Conduct kickoff meeting;
- Administer team alignment meetings;
- Align project plans;
  - Align stakeholder management plans;
  - Agree on cash flow, schedule of values, and schedule;
  - Align quality management plans and risk management plan;
  - Align construction implementation plans with CM-GC and agency;
  - Execute partnering plan and align team integration; and
  - Develop a project plan package.

4.3 Alignment Phase Contract Administration Tools

In this phase, the alignment that began during procurement continues. Alignment must occur internally, within and across the agency, design team, and CM-GC. Additionally, alignment includes building a common understanding with outside stakeholders, such as regulatory agencies, utility companies, and local municipalities.

For decades, D-B-B has been the traditional method of delivery. Thus, agencies, engineers, and contractors have long-established processes and a history of roles and relationships in the D-B-B environment. Seeking alignment in goals, processes, and responsibilities is important for any project, but it is especially important when an agency is implementing alternative contracting methods. Miscommunication and misunderstanding can result when project participants are not aligned. Alternatively, by investing in alignment, project teams clarify what to do, how to accomplish it, and who is responsible for leading various tasks.

Teams with strong alignment can expect to be more collaborative, efficient, and unified.

Appointing a champion leads to higher reliability of the project(s) going well, especially as the agency is in the early stages of implementing CM-GC.

A CM-GC champion can help keep alignment a priority at the start of the contract and throughout the project. A CM-GC champion is a key team leader who is knowledgeable about the CM-GC process and how it differs from D-B-B. To assist with project team alignment and help mitigate any team conflicts, the CM-GC champion must also be very knowledgeable of the project goals. Ideally, the champion would have been a part of the project delivery selection process and the establishment of project goals that are in alignment with the advantages of the CM-GC contracting method (see Chapter 9, Section 9.2, Goal 2).

During procurement, the agency can begin to develop alignment expectations with a number of tools. A 3 Glossary of Terms can be included in the agency's alternative contracting methods manual and the project RFQ and RFP to provide a foundation for universally accepted terms related to contract language.

Likewise, 2 Roles and Responsibilities is a tool often represented as a table that clarifies which team member is responsible for which tasks. It is particularly important when team members are new to CM-GC delivery. It can prevent tasks from falling through the cracks. 7 CM-GC Management Fee Table clearly shows costs for which the CM-GC can and cannot charge a fee.

The 4 External Stakeholder Coordination Plan is another tool to manage stakeholder involvement and input by identifying key times when specific outreach actions will be taken with stakeholders. This is especially useful with local jurisdictions or developers that are requesting and funding project betterments. Federally funded projects will involve FHWA, and some of these team members may be new to CM-GC. 10 FHWA Involvement Overview helps ensure that required meetings, reviews, and tasks that involve FHWA take place. If the agency has obtained or begun any permitting processes, the corresponding requirements can be recorded in 11 Permit Commitment Database, which can be shared with the CM-GC to ensure the project team makes decisions and takes actions in line with these commitments.

Agencies choose to partner on select D-B-B projects because it has been proven to improve performance, but partnering is critical on all CM-GC projects due to the unique agency, engineer, and contractor roles.

Communication fosters team alignment, and team meetings, such as the 1 Kickoff Meeting, help to further focus the team on project objectives and challenges and introduce team members to the people involved in various tasks. It is common for projects to hold a kickoff meeting, but a 1 Kickoff Meeting provides the additional opportunity for the team to review CM-GC processes and the division of roles and responsibilities.

Partnering can also build alignment with agency and CM-GC team members through the 8 CM-GC–Specific Partnering process with partnering meetings and assessments. Additionally, partnering can occur with outside stakeholders through 5 Regulatory Agency Partnering. The CM-GC team can better understand regulator concerns before design progresses and the regulatory agency can better understand project-specific constraints before reviewing permit applications.

Another tool to facilitate collaboration between team members is 6 Co-Location of Key Personnel, which brings the agency, engineer, and contractor under one roof to expedite communication and feedback. 9 Continuity of Team Members is used to build a history and understanding of project decisions as the project moves through different design phases and into construction.

The agency should employ tools for building team alignment early in the project. Additionally, the agency can apply these tools throughout project development and reap benefits in all phases of a project. For example, if the project team adds new team members during final design or at the start of construction, then they may need to revise the CM-GC roles and responsibilities and revisit the CM-GC–specific partnering activities. Building team alignment is a fundamental part of unifying individuals and organizations. Alignment reduces uncertainty about where a team is going and how they are getting there. In turn, alignment leads to more efficient project execution.

Table 4.1 lists the alignment phase tools. It also includes recommendations for tool use with levels of project size and complexity. The tool descriptions in Appendix A elaborate on the tools and their applicability by project complexity and size.

Table 4.1. Summary of construction manager–general contractor alignment phase tools.

Tools for Construction Manager–General Contractor Alignment	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	Construction	Closeout	**Noncomplex**	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
Phase 1. Administer Alignment Between Construction Manager–General Contractor and Agency											
1 Kickoff Meeting	✓					●	●	●	●	●	●
2 Roles and Responsibilities	✓					◗	●	●	●	●	●
3 Glossary of Terms	✓					●	●	●	●	●	●
4 External Stakeholder Coordination Plan	✓	✓				◗	●	●	◗	●	●
5 Regulatory Agency Partnering	✓	✓	✓			○	●	●	◗	●	●
6 Co-Location of Key Personnel	✓	✓	✓			○	◗	●	○	◗	●
7 Construction Manager–General Contractor Management Fee Table	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
9 Continuity of Team Members	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
10 FHWA Involvement Overview	✓	✓	✓	✓	✓	●	●	●	●	●	●
11 Permit Commitment Database	✓	✓	✓	✓	✓	◗	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

4.4 Summary

The alignment phase of a project is a joint effort between the agency, engineer, and CM-GC. The tools in this chapter are those that agencies can use to administer alignment. Before tools are implemented, they should be explained to the team and modified for the project conditions or agency context. The alignment phase helps build a foundation of trust and collaboration that can serve the team throughout the project. Clear communication from the start is extremely important to foster a collaborative environment. The primary goal of these tools is to help project participants communicate, document, plan, and execute the project efficiently. This list of tools may inspire agencies to develop new tools or adapt some of these tools based on the needs of a particular project or the organizational structure of their agency.

CHAPTER 5

Design Phase Administration

5.1 Introduction

This chapter discusses the design phase and presents tools that contribute to design development. It addresses

- CM-GC design process overview and
- Design phase contract administration tools.

The agency engineer is ultimately responsible for the design. However, the CM-GC process will inform the design phase using the contractor and, potentially, the independent cost estimator's construction knowledge. The agency, engineer, and CM-GC collaborate as an integrated team. The agency plays a key role in keeping communication channels open during design by providing timely feedback. Design should proceed so as to achieve a safe and functional facility that meets standards and benefits from the efficiency of constructability input. Design plans should provide adequate guidance for construction, rather than for bidding. Design plans should also meet the agency's as-built requirements.

5.2 Construction Manager–General Contractor Design Process Overview

The design phase of a CM-GC project resembles that of a D-B-B project. There is a separate engineer and contractor, as opposed to D-B when one entity is responsible for completing design and construction. The CM-GC phase is different from D-B-B due to the involvement of the construction manager. The engineer strives to develop a design to optimize the contractor's means and methods. The engineer can also provide multiple construction contract packages to allow for ordering long-lead items or for phasing construction to shorten the delivery period. The outputs of the design are the design documentation; environmental, utilities, and permitting restrictions; and construction work packages. Key activities for the design phase include the following:

- Ensure design compliance.
  - Ensure environmental compliance.
  - Manage utilities and permits.
  - Manage right of way and temporary construction easements.
  - Ensure functional requirements.
  - Ensure schedule requirements.
- Manage work package coordination.
- Review design package.
- Approve design invoice.

- Manage design documentation.
- Enact a contract modification, which impacts design.
- Negotiate post-design services.

5.3 Design Phase Contract Administration Tools

In this phase, the agency seeks to facilitate design development. Agency staff or consulting engineers may perform design. There is a contractual separation of design and construction. The CM-GC does not perform design but provides construction feedback on design. In this phase, agency administration tasks focus on infusing contractor knowledge in design to maximize construction efficiency, as well as allocating risk equitably to minimize costs.

Agency administration tools should facilitate innovation that achieves project goals while maintaining safety and quality in a cost-effective and timely manner.

Agencies have developed design standards to promote consistency and avoid risk. CM-GC project delivery can have alternative project goals (e.g., increasing innovation or accelerating project schedules). When project teams need to promote innovative ideas, they can use 16 Deviations from Agency Standards. This tool allows for innovation beyond the traditional D-B-B design standards but documents any exceptions and the reasoning behind them. By clearly articulating this approach, the design team can focus more easily on project goals and select suitable standards—perhaps from other states—or specifications unique to the project that will meet the agency's goals.

CM-GC partnering can go beyond the agency, engineer, and CM-GC to include FHWA and regulatory agencies and to ensure that all stakeholders have input in key design decisions.

The design team needs to know when to interact with FHWA on federally funded projects. 10 FHWA Involvement Overview clarifies when FHWA staff are invited to meetings and when they are to receive required design documents. Collaboration between the agency, engineer, CM-GC, and FHWA on federally funded projects can be structured and strengthened with 8 CM-GC–Specific Partnering. Partnering can help bring people together and keep them communicating during the design process. 5 Regulatory Agency Partnering can promote good working relationships between the regulatory agencies and the team during design. This can save time because the parties can review site constraints and design options together before a permit application is prepared and submitted. An 11 Permit Commitment Database can be developed during design to help ensure that commitments made during the design phase are carried out during construction.

When jurisdictions, utilities, and other stakeholders are involved, the 4 External Stakeholder Coordination Plan can be implemented so their feedback can be considered in design as early as possible. 19 Public Announcements is a tool to keep the public informed about the project scope, schedule, budget, and how the CM-GC delivery method will benefit the project.

Research for this guidebook found that agencies view 9 Continuity of Key Team Members as a tool for project success rather than just a process. Continuity means that the agency, engineer, and CM-GC staff that worked on the project during procurement and alignment continue to work on it during design. These staff members help ensure continuity so that issues that have been decided previously are not discussed again and so that the project understanding that was built during alignment allows the design to proceed smoothly.

6 Co-Location of Key Personnel involves physically locating key team members from the agency, engineer, and CM-GC in a single location. Design can require significant interface

between many disciplines, and having everyone physically nearby helps facilitate timely communication. As design issues are being discussed, decisions need to be made. 20 Delegation of Authority is a tool that puts decision-making authority into the hands of the agency's engineer in charge of the project. This brings confidence to the team that decisions will be made in a timely manner by people knowledgeable about the project.

A number of tools serve to bring relevant team members together during the design process. 12 Discipline Task Force brings together team members from the agency, engineer, and CM-GC to advance design relative to a specific discipline. 15 In-Progress Design Workshops bring together team members from different disciplines so that multiple perspectives and factors can be taken into account during design. In-progress design workshops are meant to develop and discuss design options; however, 17 Over-the-Shoulder Reviews focus on obtaining review comments on a specific design option. To supplement agency labor and expertise, some agencies use 13 Independent Party Design Reviews to move the design process forward in a timely manner. The variety of project team members and disciplines reviewing and providing feedback on the design provides a form of quality control.

Schedule acceleration is perhaps the most common CM-GC project goal, so agencies must support an accelerated design process through team-oriented tools.

The CM-GC process allows engineers to expedite the design process by focusing on what a single contractor requires for construction. This is opposed to the D-B-B process, where designs must allow for multiple contractors to bid for the plans. However, the agency will need to have a set of as-built plans at the end of the project for asset management. To this end, 14 Plan Standards focus on the content that agencies will need for as-built drawings.

Design phase tools are initiated in either the alignment or design phases. Tools for the design phase can help team members understand their roles during the design phase and encourage communication and collaboration. Some of the tools in this phase help move the design process forward while minimizing the need for iteration and rework. Tools to integrate feedback during design can facilitate project progress and provide a form of QC. Tools that clarify how to handle deviations from plan standards and agency design standards can help keep the project team focused on project goals and contract requirements. Establishing patterns of strong communication and collaboration during design can support a strong construction phase.

Table 5.1 lists the design phase tools. It also includes recommendations for tool use with levels of project size and complexity. The tool descriptions in Appendix A elaborate on the tools and their applicability by project complexity and size.

5.4 Summary

The design phase of a project is a collaborative effort between the agency, the engineer, and the CM-GC. This chapter highlighted tools that agencies can use to administer design. Approximately half of the tools for this chapter were initiated in the alignment phase. Therefore, team members should already be familiar with using these tools. The agency will introduce the team to any new tools that begin in the design phase. The primary goal of these tools is to help project participants communicate, document, plan, and execute design efficiently. This list of tools may inspire agencies to develop new tools or adapt some of these tools based on the needs of a particular project or the organizational structure of their agency. Appendix A provides additional information on tools that were generously provided for this guidebook by leading agencies.

Table 5.1. Summary of construction manager–general contractor design phase tools.

Tools for Construction Manager–General Contractor Design	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
Phase 2. Administer Design of Construction Manager–General Contractor Project											
4 External Stakeholder Coordination Plan	✓	✓				◗	●	●	◗	●	●
5 Regulatory Agency Partnering	✓	✓	✓			○	●	●	◗	●	●
6 Co-Location of Key Personnel	✓	✓	✓			○	◗	●	○	◗	●
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
9 Continuity of Team Members	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
10 FHWA Involvement Overview	✓	✓	✓	✓	✓	●	●	●	●	●	●
11 Permit Commitment Database	✓	✓	✓	✓	✓	◗	●	●	●	●	●
12 Discipline Task Force		✓				○	◗	●	◗	●	●
13 Independent Party Design Review		✓				○	●	●	○	●	●
14 Plan Standards		✓	✓			◗	◗	●	◗	●	●
15 In-Progress Design Workshops		✓	✓			◗	●	●	●	●	●
16 Deviations from Agency Standards		✓	✓			◗	●	●	◗	●	●
17 Over-the-Shoulder Reviews		✓	✓			◗	●	●	●	●	●
19 Public Announcements		✓	✓	✓	✓	○	●	●	◗	●	●
20 Delegation of Authority		✓	✓	✓	✓	●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

CHAPTER 6

Preconstruction Phase Administration

6.1 Introduction

This chapter introduces the preconstruction phase and presents contract administration tools that contribute to successful preconstruction. This chapter addresses

- CM-GC preconstruction process overview and
- Preconstruction phase contract administration tools.

In the preconstruction phase, the agency ensures that there are opportunities for the CM-GC to provide input on the design to enhance constructability and innovation. Additionally, the agency administers the cost-estimating process with input from the engineer, the independent cost estimator, and the CM-GC. The key deliverables of this phase are the GMP and construction work packages. Scheduled and impromptu communication are necessary to develop a high level of collaboration between the various stakeholders engaged in the preconstruction phase.

6.2 Construction Manager–General Contractor Preconstruction Process Overview

Traditional D-B-B project delivery has a clear separation of the engineer and constructor roles, and construction is awarded to the lowest bidder. In contrast, the CM-GC contracting method involves the general contractor in several aspects of design. The CM-GC firm does not perform design but provides preconstruction services, such as constructability reviews, scheduling, progressive cost estimates, construction phasing, value engineering, risk management, and other design-related support activities. Rather than competitive bidding, which prioritizes cost at the expense of all other key metrics, the CM-GC process uses a GMP process for construction work package pricing and may involve negotiations to determine the agreed-upon price. Agencies and contractors complete this process in cooperation with an independent cost estimator to act as an objective third party in the price negotiations. Key activities for the preconstruction phase typically include the following:

- Review CM-GC input for design,
- Approve design changes based on CM-GC input,
- Approve CM-GC preconstruction services invoices,
- Review project management plans,
- Negotiate GMP,
- Enact CM-GC contract modifications, and
- Manage CM-GC documentation.

6.3 Preconstruction Phase Contract Administration Tools

In this phase, the agency seeks to facilitate preconstruction services from the CM-GC that can enhance the design and the built facility. In this phase, agency administration tasks focus on ensuring that the preconstruction services are performed in alignment with project goals and in collaboration with other project stakeholders. The agency will also want to ensure that preconstruction services are integrated into the design to facilitate innovation that achieves project goals while maintaining safety and quality in a cost-effective and timely manner.

An agency can foster innovation on a CM-GC project by implementing a variety of tools. For example, 16 Deviation from Agency Standards creates an atmosphere where the CM-GC firm can think outside the box in search of new ways to achieve project goals. Innovative ideas with cost implications can be captured by the 25 Cost–Savings Matrix, a table that describes each innovation and lists the individual(s) responsible for researching the idea, the potential costs and benefits, and the project team's decision of whether to implement the innovation.

During the preconstruction phase, the CM-GC firm should strive to understand the design goals, and the engineer should strive to understand the construction goals. 8 CM-GC–Specific Partnering can help foster mutual understanding. In addition, 5 Regulatory Agency Partnering can promote smooth working relationships with regulatory agencies. In a traditional D-B-B project, a contractor may not deal directly with obtaining permits from regulatory agencies. But in a CM-GC project, preconstruction services may place the CM-GC in direct contact with regulatory agencies. Partnering is one tool that can strengthen relationships and open channels of communication. FHWA can be a stakeholder on federally funded projects. 10 FHWA Involvement Overview clarifies when FHWA staff are invited to participate in project meetings and when they are required to receive specific design documents. When jurisdictions, utilities, and other entities have a stake in the project, 4 External Stakeholder Coordination Plan can be implemented so that their design feedback is considered as early as possible. 19 Public Announcements keep the general public informed about the project scope, schedule, budget, and how the CM-GC delivery method will benefit the project.

9 Continuity of Team Members means that the agency, engineer, and CM-GC staff that worked on the project during procurement and alignment continue to work on it during the preconstruction phase. These project team members help ensure continuity so that the issues that have been decided previously are not reopened, and the project understanding that was built during alignment allows design—and later, construction—to proceed smoothly. 6 Co-Location of Key Personnel allows key team members from the agency, engineer, and CM-GC firm to be in one physical location. Preconstruction services can require significant interface between many disciplines; having everyone nearby helps facilitate efficient and timely communication. As preconstruction services are performed, decisions need to be made. 20 Delegation of Authority puts the decision-making authority into the hands of the agency's engineer in charge of the project. This brings confidence to the team that decisions will be made in a timely manner by people knowledgeable about the project.

To perform preconstruction services effectively, the CM-GC firm has to be well integrated into the design process. 15 In-Progress Design Workshops bring together team members from different disciplines so that multiple perspectives and factors can be taken into account during design. In-progress design workshops are meant to develop and discuss various design options. However, 17 Over-the-Shoulder Reviews focus on obtaining review comments on one specific design option. In these meetings, the CM-GC can offer key information about the design's constructability, construction cost, and schedule implications. 11 Permit Commitment Database can be used during preconstruction services to help the CM-GC ensure that the feedback and work products developed comply with all agreements. The 14 Plan Standards tool streamlines

the design development by focusing on plans that contain content the agency will need for as-built records. Because the CM-GC is actively participating in design through preconstruction services and has a thorough understanding of the project scope, designs for construction tasks that the general contractor will self-perform may not need to be developed to the level traditionally required for bidding, which can save time and effort.

As discussed, contractor input with regard to the constructability of the design is a major benefit of CM-GC. These constructability reviews are tasks completed by the CM-GC firm; there is no agency tool labeled constructability review. However, agencies use various tools that help facilitate this constructability input. For example, tools such as 17 Over-the-Shoulder Reviews, 15 In-Progress Design Workshops, and 22 Cost-Modeling Approach, help ensure that constructability input is occurring during design development. Moreover, design and preconstruction services are separate contracts. Therefore, FHWA requires a value engineering process on federally funded CM-GC projects (Value Engineering 2014).

FHWA requires a value engineering process on federally funded CM-GC projects.

The CM-GC firm provides progressive cost estimates, a key preconstruction service. Before the first cost estimate is produced, the team can come together to develop a 22 Cost-Modeling Approach that clarifies assumptions, means and methods, and baseline production rates. This tool is especially helpful early in design to reconcile the scope and budget. 7 CM-GC Management Fee Table documents which costs will have the CM-GC's fee attached to them, ensuring that the individuals preparing an estimate and those reviewing the estimate are all on the same page. In addition to the CM-GC estimate, the agency can contract with a 24 Independent Cost Estimator to prepare a cost estimate separate from the CM-GC but consistent with the cost model. The agency can use a 21 Cost-Comparison Spreadsheet to determine where the CM-GC and independent cost estimator estimates are similar and different. For construction activities that the team deems risky, 27 Risk Pools are developed. Specific risks have budgets that are included in the estimate. Some risks pools are agency controlled, and other risks are CM-GC controlled. When design nears completion, the 26 Opinion of Probable Construction Cost Process begins. The CM-GC prepares a price proposal. The independent cost estimator also prepares a cost estimate that is used as a 23 CM-GC Bid Validation because the price proposal is negotiated and not competitively bid. With 18 Open-Book Estimating, the agency can review the CM-GC books to see how the price proposal was built up, which allows another way to validate the price proposal.

Preconstruction services overlap with design and need to be well integrated with the design. Some of the tools used in the preconstruction phase are initiated in the alignment phase and may also be used by the agency to administer design. Tools used for the preconstruction services phase can help promote innovation during design. Some of the tools help integrate preconstruction services into the design process so that the design can benefit from constructability reviews, progressive cost estimates, scheduling, and phasing. Preconstruction services will ultimately lead to an enhanced design and a price proposal that can be used to facilitate successful price negotiations. Tools for the preconstruction phase are listed in Table 6.1.

6.4 Summary

The preconstruction phase of a project brings together the agency, the engineer, and the CM-GC to incorporate design input related to constructability, innovation, risk pools, schedule, and cost. The tools in this chapter highlight tools agencies can use to administer preconstruction. More than half of the tools for this phase were used in one or more of the earlier phases. Therefore, team members should already be familiar with using some of these tools. The tools related to cost estimation and development of the probable construction costs are unique to the preconstruction phase. Therefore, the agency should introduce the

Table 6.1. Summary of construction manager–general contractor preconstruction phase tools.

Tools for Construction Manager–General Contractor Preconstruction	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	<= $10 million	$10 million–$50 million	> $50 million
Phase 3. Administer Preconstruction Services of a Construction Manager–General Contractor Project											
5 Regulatory Agency Partnering	✓	✓	✓			○	●	●	◗	●	●
6 Co-Location of Key Personnel	✓	✓	✓			○	◗	●	○	◗	●
7 Construction Manager–General Contractor Management Fee Table			✓	✓	✓	◗	●	●	◗	●	●
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
9 Continuity of Team Members	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
10 FHWA Involvement Overview	✓	✓	✓	✓	✓	●	●	●	●	●	●
11 Permit Commitment Database	✓	✓	✓	✓	✓	◗	●	●	●	●	●
14 Plan Standards		✓	✓			◗	◗	●	◗	●	●
15 In-Progress Design Workshops		✓	✓			◗	●	●	●	●	●
16 Deviations from Agency Standards		✓	✓			◗	●	●	◗	●	●
17 Over-the-Shoulder Reviews		✓	✓			◗	●	●	●	●	●
18 Open-Book Estimating			✓	✓		◗	●	●	◗	◗	●
19 Public Announcements		✓	✓	✓	✓	○	●	●	◗	●	●
20 Delegation of Authority		✓	✓	✓	✓	●	●	●	●	●	●
21 Cost-Comparison Spreadsheet			✓			◗	●	●	◗	●	●
22 Cost-Modeling Approach			✓			◗	●	●	◗	●	●
23 Construction Manager–General Contractor Bid Validation			✓			◗	●	●	◗	●	●
24 Independent Cost Estimator			✓			◗	●	●	◗	●	●
25 Cost–Savings Matrix			✓			◗	●	●	◗	●	●
26 Opinion of Probable Construction Cost Process			✓			◗	●	●	◗	●	●
27 Risk Pools			✓	✓		○	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

team to these new tools to make sure there is a common understanding of their purpose, use, and timing. The primary goal of contract administration tools is to help project participants communicate, document, plan, and execute preconstruction efficiently. The tools provided in this guidebook may inspire agencies to develop new tools or adapt some of the available tools based on the needs of a particular project or the organizational structure of their agency. Detailed information on each tool and various examples generously provided by leading agencies are available in Appendix A.

CHAPTER 7

Construction Phase Administration

7.1 Introduction

This chapter discusses agency administration of the CM-GC construction phase and presents tools that contribute to successful construction. This chapter addresses

- CM-GC construction process overview and
- Construction phase contract administration tools.

The CM-GC has in-depth knowledge of the design intent and the design itself due to participating in the design and preconstruction phases. The agency's contract administration during construction should ensure that adequate construction progress is being made and that quality requirements are being achieved. Work must be measured and paid for, and any change orders or disputes must be resolved. CM-GC projects are often fast-tracked, so the agency should be prepared with an adequate assignment of internal or consultant staff to participate in contract administration activities during construction.

7.2 Construction Manager–General Contractor Construction Process Overview

CM-GC construction administration shares many similarities with the traditional D-B-B process. Ultimately, the same technical requirements are met using the same basic materials in both delivery methods. State DOTs can choose to administer QA-QC processes in the same manner as D-B-B, but they can also choose to shift some traditional QC roles to the contractor. The primary difference in construction administration revolves around the use of discrete work packages to facilitate faster construction. Administration of these work packages can be more demanding compared with D-B-B processes. Key agency activities in the construction phase include

- Manage legal relations.
- Manage public relations.
- Manage materials.
  - Sample and verify materials.
  - Test materials.
  - Certify materials.
- Control and inspect work.
  - Inspect work for conformance to plans and specifications.
  - Document the daily work, compliance, and quality.
  - Manage the request for information process.
  - Manage the submittal process.
  - Monitor CM-GC and QA-QC.

  - Manage nonconformances.
  - Review nonconformance design solutions.
  - Review completion of punch list items.
- Review potential additional scope.
  - Receive shared risk contingency.
  - Review state DOT risk contingency.
- Execute supplemental agreements.
  - Receive change orders.
  - Estimate cost and time adjustments.
  - Negotiate cost and time adjustments at site level.
  - Review change orders.
  - Execute change orders.
- Resolve disputes.
- Measure progress, and pay contractor.
  - Receive contractor invoices.
  - Review payment invoices.
  - Execute payments.
- Acquire project completion documentation.
- Ensure that as-builts are being developed by the engineer and CM-GC.

7.3 Construction Phase Contract Administration Tools

In this phase, the agency seeks to facilitate construction progress. At this stage, the CM-GC firm should have a thorough understanding of the project. A significant portion of the innovative ideas should have been vetted during preconstruction. However, additional innovation can still originate from subcontractors and suppliers who are asked to propose ideas for portions of the work. A key goal of the construction phase is ensuring quality. The agency can encourage quality construction using tools such as electronic data management and quality-based incentives.

Some previously discussed tools can add value to the construction phase. For example, 8 CM-GC–Specific Partnering strengthens relationships and builds communication channels that can help the agency, engineer, and CM-GC firm work through issues that arise during construction. 9 Continuity of Team Members carries forward project knowledge from the design phase to the construction phase. 11 Permit Commitment Database serves to preserve commitments that the project team made during the design phase to help ensure that permit commitments are not forgotten or violated during construction. 20 Delegation of Authority facilitates timely decision-making so construction can proceed without unnecessary delay. For construction changes and construction as planned, 18 Open-Book Estimating provides the agency with a mechanism for checking cost competitiveness and construction progress. Typically, the public is not familiar with the CM-GC process and potential benefits. The 19 Public Announcements tool can help inform the public about the specific benefits CM-GC is bringing to the construction project.

A number of tools relate specifically to promoting quality during construction. Many agencies are able to use their standard QA-QC processes on CM-GC projects, especially with noncomplex projects. However, a number of tools have been developed to take advantage of opportunities that CM-GC delivery offers. A quality program can be adjusted to the context of a specific project using 29 Contractor Involvement in Establishing QC Standards. Additionally, 28 Contractor-Controlled QC Testing puts the responsibility for QC testing into the hands of the CM-GC—or a third party the CM-GC contracts with—instead of the agency itself. These options must be in compliance with 23 CFR 637 on federally funded projects. This added responsibility can keep the CM-GC more alert to QC requirements and test results so that construction processes can adjust quicker to quality needs. Construction projects can generate

a lot of data and paperwork, especially related to quality. The 30 Real-Time Electronic QM Information tool can be used for efficient data management and record tracking. The 31 Witness and Hold Points tool helps the project team avoid construction errors or rework by bringing team members together at critical points to witness the work completed up to that point before continuing with the work. Meeting or exceeding construction quality is an important task for a CM-GC firm. Any of the aforementioned tools that address quality could be part of a broader quality program. Additional guidance on quality programs can be found in *NCHRP Report 808* (Molenaar et al. 2015).

Throughout construction, the CM-GC will submit invoices for completed work. Having a structured pay request process helps the agency receive the necessary information in the appropriate format for efficient reviews, and it helps the CM-GC get paid promptly. The 32 Payment Checklist tool is used to identify which party is responsible for each task in the payment process. The 7 CM-GC Management Fee Table tool identifies the costs to which fees are tied.

Some of the tools used by the agency in the construction phase are initiated in the alignment, design, or preconstruction phases. Other tools are intended for the construction phase only. Many of these tools focus on achieving quality requirements. Tools in the construction phase, listed in Table 7.1, can help the project team work collaboratively and efficiently. Detailed information on each tool and examples generously provided by leading agencies are available in Appendix A.

Table 7.1. Summary of construction manager–general contractor construction phase tools.

Tools for Construction Manager–General Contractor Construction	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
Phase 4. Administer Construction of Construction Manager–General Contractor Project											
7 Construction Manager–General Contractor Management Fee Table			✓	✓	✓	◗	●	●	◗	●	●
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
9 Continuity of Team Members	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
10 FHWA Involvement Overview	✓	✓	✓	✓	✓	●	●	●	●	●	●
11 Permit Commitment Database	✓	✓	✓	✓	✓	◗	●	●	●	●	●
18 Open-Book Estimating		✓	✓	✓		◗	●	●	◗	◗	●
19 Public Announcements		✓	✓	✓	✓	○	●	●	◗	●	●
20 Delegation of Authority		✓	✓	✓	✓	●	●	●	●	●	●
28 Contractor-Controlled Quality Control Testing				✓		●	●	●	●	●	●
29 Contractor Involvement in Establishing Quality Control Standards				✓		◗	●	●	◗	●	●
30 Real-Time Electronic Quality Management Information				✓		●	●	●	●	●	●
31 Witness and Hold Points				✓		◗	●	●	◗	●	●
32 Payment Checklist				✓	✓	●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

7.4 Summary

The construction phase of a project is a joint effort between the agency and the CM-GC. The tools in this chapter highlight tools that agencies can use to administer construction. About half of the tools for this phase were used in one or more of the earlier project phases. Therefore, the project team should already be familiar with using these tools. The agency should introduce the team to any new tools that will be implemented in the construction phase, especially the quality-related tools. The primary goal of these tools is to help project participants communicate, document, plan, and execute construction efficiently. The list of tools presented in this chapter may inspire agencies to develop new tools or adapt some of these tools based on the needs of a particular project or the organizational structure of their agency.

CHAPTER 8

Closeout Phase Administration

8.1 Introduction

This chapter introduces the closeout phase and presents tools that facilitate administering the CM-GC project closeout. It addresses

- CM-GC closeout process overview and
- Closeout phase contract administration.

When a highway project covers a long distance, the closeout phase may be spread over a long time. A proactive approach to the administration of closeout will help ensure that all closeout activities are completed in a timely manner before project activities wind down and allow team members to move on to other projects.

8.2 Construction Manager–General Contractor Closeout Process Overview

Closeout is the final phase of CM-GC contract administration. This phase ensures that the project scope is completed and that all activities are well documented. In general, the CM-GC closeout process is similar to the D-B-B closeout process. There are only a few differences for CM-GC closeout. For example, the engineers may provide less detail in some of their designs because they only needed to design for one contractor's interpretation. In some cases, then, as-built plans may need additional detail to comply with agency requirements for record drawings. Key activities in the closeout phase include

- Conduct final inspection.
  - Perform inspection.
  - Review punch list work.
- Review final turnover documentation.
  - Review as-built plans.
  - Review contractor turnover documentation.
  - Review contractor payments.
- Review invoice for final payment.
- Review corrective action completion.
- Execute contractor release.
- Conduct contractor evaluation and lessons learned.
- Execute warranties.

8.3 Closeout Phase Contract Administration Tools

In this phase, the agency seeks to ensure the completion of construction and facilitate the transfer of responsibility of the completed project from the CM-GC firm. As introduced earlier, these actions may include conducting final inspections, receiving turnover documentation, and reviewing corrective actions. Activities leading up to closeout are typically initiated early in the project so that the appropriate project documentation can be made available in the closeout phase.

Construction challenges and the push to close out a project can strain relationships. The 9 Continuity of Team Members tool can help support closeout activities because the same key people working on the project during early alignment, design, preconstruction, and construction are also involved in closeout. Decisions and agreements made earlier in the project are more easily remembered and fulfilled when key team members have been involved throughout the project. Using the 8 CM-GC–Specific Partnering tool during the project—from procurement until closeout—can provide a team with a framework for working collaboratively and efficiently. Federally funded projects will have FHWA requirements at the closeout phase, and 10 FHWA Involvement Overview can help the team keep track of these requirements. Some permit commitments with regulatory agencies may also be a part of closeout, and the 11 Permit Commitment Database tool can facilitate compliance.

The 20 Delegation of Authority tool facilitates timely decision-making when questions arise related to payment, punch list items, claims, warranties, and other documentation. 32 Payment Checklist clarifies the steps for invoicing and final payment, as well as responsibilities for each activity. 7 CM-GC Management Fee Table identifies project costs to which CM-GC fees are tied, including costs incurred late in the project. By closeout, the public has lived through a period of construction, and 19 Public Announcements can help communicate the benefits—such as time, cost, access, and safety—that the project achieved.

Closeout is a continuation and culmination of the construction phase, with the added requirements of finalizing documentation and payments. Some of the tools used in earlier phases can and should continue to be used during closeout. Tools used in closeout help the project team fulfill project goals, permit requirements, and contract requirements. Closeout administration tools are listed in Table 8.1.

8.4 Summary

The closeout phase of a project is a joint effort between the agency and the CM-GC firm. This chapter highlights tools that agencies can use to administer CM-GC project closeout. All of the tools for this final phase were used in one or more of the earlier phases. So, by the time the project gets to closeout, the team should have a good process in place for using these tools. The primary goal of these tools is to help project participants communicate, document, plan, and execute closeout efficiently. The tools presented in this guidebook may inspire agencies to develop new tools or adapt some of the existing tools based on the needs of a particular project or their agency's organizational structure. Detailed information on each tool—and various examples generously provided by leading agencies—are available in Appendix A.

Table 8.1. Summary of construction manager–general contractor closeout phase tools.

	Contract Administration Phase					Project Complexity			Project Size		
Tools for Construction Manager–General Contractor Closeout	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
Phase 5. Administer Closeout of Construction Manager–General Contractor Project											
7 Construction Manager–General Contractor Management Fee Table			✓	✓	✓	◗	●	●	◗	●	●
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
9 Continuity of Team Members	✓	✓	✓	✓	✓	◗	●	●	◗	●	●
10 FHWA Involvement Overview	✓	✓	✓	✓	✓	●	●	●	●	●	●
11 Permit Commitment Database	✓	✓	✓	✓	✓	◗	●	●	●	●	●
19 Public Announcements		✓	✓	✓	✓	○	●	●	◗	●	●
20 Delegation of Authority		✓	✓	✓	✓	●	●	●	●	●	●
32 Payment Checklist				✓	✓	●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

CHAPTER 9

Guidebook Implementation

9.1 Introduction

Implementation of CM-GC contract administration occurs in the context of the larger organization. This chapter provides guidance on identifying

- Strategies for meeting implementation goals at the organizational level,
- Tools for meeting implementation goals at the project level,
- Personnel and resources for implementation at both organizational and project levels, and
- Aspects of organizational culture important to CM-GC contract administration.

Table 9.1 summarizes implementation goals at the organization and project levels. Strategies discussed here are those presented in Chapter 2, and tools discussed here are those presented in Chapters 3 through 8 of this guidebook.

9.2 Organizational-Level Goals

The organizational-level goals focus on introducing and embedding new CM-GC contract administration tasks and processes into the organization.

Organizational Goal 1. Commit to Long-Term Implementation

When an agency adopts an alternative contracting method such as CM-GC, new goals and new strategies are required to achieve those goals. A long-term commitment by the agency to embrace CM-GC processes prevents the agency from reverting to processes and tools used for traditional delivery. In many cases, it is not a matter of making minor adjustments to existing D-B-B processes but of implementing totally new processes. Adopting, disseminating, and explaining organizational goals and strategies such as those presented here help to demonstrate long-term commitment. Additionally, an agency demonstrates long-term commitment when implementing a plan of continuous improvement with the CM-GC related organizational strategies. This continuous improvement involves evaluation of the CM-GC strategy by tracking implementation and measuring performance.

Strong commitment at the organizational level helps provide a framework for CM-GC to be successfully implemented at the project level.

Organizational Goal 2. Assign Roles and Responsibilities

An organization can make progress on strategies when people within the organization know their roles and responsibilities relating to those strategies. The roles and responsibilities of leaders within a GM-GC project include

Table 9.1. Implementation goals

Agency Level	Implementation Focus	Implementation Goals
Organization	Strategies	• Commit to long-term implementation. • Assign roles and responsibilities. • Assess and adjust current strategies. • Communicate agency direction for CM-GC contract administration. • Train organizational team members. • Develop methods to measure and evaluate performance.
Project	Tools	• Assess existing tools. • Identify appropriate tools based on project characteristics. • Train project team members. • Test new tools. • Evaluate the performance of tools.

- **CM-GC coordinator**—A CM-GC coordinator is involved in the procurement of every CM-GC project within the agency.
- **Alternative contracting methods officer**—An alternative contracting methods officer supports project managers in all aspects of procurement and contract administration.
- **Discipline-specific leads**—These agency-level leaders should understand how the CM-GC process will change reviews into an iterative process incorporating contractor feedback on cost and schedule.
- **Upper-level administrators**—Upper-level administrators can incentivize staff performance by emphasizing the implementation of CM-GC processes on CM-GC projects.
- **CM-GC champion**—An agency staff member who advocates for proper implementation of CM-GC practices on a project. This person could be a designated agency staff member on the project team or the alternative contracting methods officer.

Creating and improving strategies require a commitment of time and resources. The most efficient way to ensure success is for the agency leaders to assign and train team members to direct and monitor implementation. Agency staff should be involved throughout this process to incorporate ideas, opinions, and areas of expertise. However, team members taking the lead should be clearly identified. Assigning roles and responsibilities minimizes confusion and ensures that strategies to reach the implementation goals are being actively managed.

> Successful CM-GC construction administration will require agencies to assign champions who have adequate time and resources to be successful.

Organizational Goal 3. Assess and Adjust Current Strategies

Assessment can occur at two different times. The first time is before CM-GC processes or policies are in place. The second time is after implementing CM-GC processes. In either case, agency leaders want to understand the current organizational environment to reveal opportunities for improvement.

Assessment areas are current policies, procedures, and guidance documents that affect D-B-B contract administration. It is also important that the leader determines if the written agency guidance is being followed or if there are unwritten rules that are being used. Feedback from agency personnel can reveal what is working well and what needs improvement.

Document review and feedback from agency personnel will identify areas of strength and areas for improvement. The assessors should look for D-B-B delivery processes that do not fit

the goals of a CM-GC project, as this becomes a primary area for innovation and change. Once CM-GC processes are in place, the leader's assessments focus on whether agency personnel are effectively using the new CM-GC processes, if there are obstacles to effective implementation, or if agency personnel are reverting to D-B-B processes.

An assessment can show changes in the procurement process to strengthen alignment during contract administration. Alternatively, an assessment can show a gap in responsibilities or an overlap in roles. If processes are not implemented consistently, guidance may not be clear and training may be needed.

After evaluation of the existing strategies, the leader can begin incorporating new information and ideas from this guidebook. Ideas for improvement may come from the strategies for contract administration in Chapter 2 or from the tools presented in Chapters 3 through 8 and Appendix A. Updating existing policies, procedures, and guidance documents with new strategic approaches will convey long-term commitment and will promote a consistent approach to CM-GC projects.

Organizational Goal 4. Communicate Agency Direction for Construction Manager–General Contractor Contract Administration

Gaining the support of agency personnel is an important step to successfully implement new strategies. This step involves establishing a clear understanding of the new strategies and their benefits.

The strategies in Chapter 2 provide an excellent roadmap for an agency's CM-GC direction. These strategies provide a framework for the creation of agency-specific goals. For example, the Alignment Strategy can provide for a group of programmatic goals that focus on the types, sizes, and levels of complexity of projects for which an agency will use CM-GC. The Preconstruction Services Quality Strategy can provide for direction on the use of independent cost estimator services and the process for reaching GMPs on each project.

Agency leaders can host agencywide workshops as an effective way to communicate an agency's new or evolving approach to CM-GC contract administration. Workshops should focus on informing agency members of forthcoming internal changes and expected long-term benefits. Interagency memos and newsletters are other ways to communicate information and reinforce the agency's goals. The specific roles and responsibilities among individuals and team members will vary throughout the agency, as discussed below.

Organizational Goal 5. Train Organizational Team Members

When agency members have been informed about why new strategies are being introduced, they need to understand how to participate and contribute. Training can cover goals, approach, processes, benefits, and differences from D-B-B. Agency personnel involved in training at the organizational level include personnel involved in procurement, contract administration, payment, and compliance.

CM-GC training at the organizational and project level will increase the probability of successful project delivery.

Procurement personnel need to learn how to procure an independent cost estimator, as well as a CM-GC firm. The project manager and other personnel will need to be familiar with construction cost models and built-up estimates versus estimates based on historical data. Contract administration personnel should know their role during design and construction to

ensure design and construction quality. Payment personnel must understand how measurement and payment applies to a lump sum or GMP, and how to document compliance with federal requirements for federally funded projects.

The training discussed here is at the organizational level. Agency personnel at the organizational level are frequently the first to be involved with a CM-GC project, and it is important that they implement the correct approach at the earliest stages. Individuals at the organizational level may not adopt as many tools as those at the project level. To achieve effective CM-GC delivery, organizational-level personnel must understand and implement the agency's CM-GC approach as consistently as personnel at the project level.

Organizational Goal 6. Develop a Method to Measure and Evaluate Performance

It is crucial for the agency to develop a method to measure and evaluate the CM-GC program's performance to ensure goals are met and continuous improvement occurs. In developing a performance measurement methodology, an agency should consider

- What will be measured?
- How will it be measured?
- Who will perform the measurement?
- When will the measurement occur?
- What will be done with the results?

Agency leaders can use multiple performance criteria to measure the effectiveness and success of the CM-GC program. These performance criteria include measuring whether projects are being completed on budget, on schedule, and with minimal disputes. Current performance can be compared with the historical performance of the CM-GC program or with the performance of the traditional D-B-B program.

In any performance analysis, decision makers should understand the context of the data. Projects of similar size and complexity should be compared. Any unusual circumstances regarding environmental issues, utility conflicts, right-of-way acquisition, and political issues should be factored into the analysis.

Assessments can include a cost performance evaluation that compares the original agency-estimated costs to the awarded and final costs. This allows the agency to observe and potentially minimize the percent growth of project costs throughout the various stages. However, data must be analyzed in light of many variables. For example, during a time when there is a rise in construction prices, an agency estimate developed from historical prices may not provide an accurate estimate.

Much like the project costs, the agency should strive to minimize or eliminate the schedule growth of a project to reduce overhead costs and road user costs. Schedule variation analysis should take into account the agency's method and assumptions in estimating a schedule compared with a contractor's method and assumptions. Additionally, impacts of unknown conditions, agency change orders, or situations outside the contractor's control should all be considered when analyzing schedule data.

Performance assessments can include a dispute evaluation that can provide the agency with feedback on the quality of project documents and communication with the CM-GC team. Measuring the number, type, and cost of disputes will help agencies identify opportunities to improve project delivery.

Other performance criteria include safety, quality, mobility, and environmental impacts. Measuring and evaluating CM-GC performance can help an agency continuously improve CM-GC contract administration.

Agency leaders must assign the responsibility of performance measurement and evaluation to an individual or a team to ensure that it is being conducted consistently. Adequate time and resources must be dedicated to this function, which can be performed internally or contracted out to an independent evaluator.

The agency also must determine the frequency of evaluation. Frequency options include continuous measurement, or cyclical (i.e., monthly, quarterly, annually, or end of project). Monthly assessments could include partnering evaluations. Monthly, quarterly, and annual evaluations can provide data on how a project is progressing with regard to budget, schedule, and changes. End-of-project evaluations allow the project team to compare their project to benchmarks or other projects. The frequency of evaluation will vary from agency to agency depending upon program maturity and need, but it is important to select a timeframe and remain consistent. It is difficult to go back in time to collect data, so at the beginning of each project a decision should be made on what data will be collected and how frequently that data will be gathered. Measurements becomes useful when they are followed up by analysis and actions that lead to continuous improvement.

9.3 Project-Level Goals

The project-level goals focus on introducing and embedding new tasks and processes into a project.

Project Goal 1. Assess Existing Tools

Agencies have a vast institutional knowledge of D-B-B tools. The purpose and implementation of these tools is sometimes documented and sometimes unwritten. These tools have benefited from years of use and improvement, while familiarity makes their implementation second nature in many agencies. Some D-B-B tools can be used with CM-GC. However, when CM-GC processes and goals differ from D-B-B, then specific CM-GC tools should be used. Cost, schedule, quality, and other benefits of CM-GC can be lost when D-B-B tools are misapplied to the CM-GC process. Therefore, a project team must work collaboratively to implement CM-GC contract administration tools to achieve the full benefits of CM-GC delivery.

If an agency has never implemented a CM-GC project, agency leaders and project managers should first identify contract administration functions that differ from D-B-B. An agency can select, develop, or adapt tools to perform those CM-GC contract administration functions. If an agency has implemented CM-GC projects, tools currently being used on CM-GC projects should be identified and reviewed. Even if these practices are not currently referred to as tools, they may be considered tools. The definition of a tool—repeated from Chapter 1—is provided to help clarify what a CM-GC contract administration tool is.

> Tools are used to perform an operation to accomplish a specific project goal. Tools support a regular and systematic procedure to accomplishing this goal. Examples of tools include checklists, spreadsheets, guidelines, matrices, structured meetings, and more. Specific examples related to this guidebook include tools that help with oversight management, design management and quality, construction management and quality, project completion, and closeout.

When the project team has a list of available tools from past agency experience, a comparison can be made between the tools currently in use and those included in this guidebook. Project team members should ask questions about existing tools, such as the following:

- Can the purpose and implementation of existing tools be described better?
- Can existing tools be improved to perform better?
- Is an existing tool suited for D-B-B but not CM-GC, and should it be removed from the CM-GC tool kit?

Project team members should ask questions about tools from the guidebook, such as

- Should we adopt this tool from the guidebook?
- Are there tools in the guidebook that we can adapt to better meet our project needs?

Improvements to CM-GC contract administration can occur by improving existing tools and adopting or adapting new tools. An agency should investigate all of these options during the tool assessment.

Project Goal 2. Identify Appropriate Tools Based on Project Characteristics

To effectively deliver CM-GC projects, the agency and CM-GC project team should select tools that fit the project characteristics. The tool descriptions in this guidebook include recommendations regarding the appropriateness of the tool for various project sizes and complexity levels. Some tools are widely applicable, whereas other tools may be most appropriate for a project of a certain size or complexity.

For example, the tool that identifies roles and responsibilities—2 Roles and Responsibilities—is appropriate for all project sizes. However, the tool 4 External Stakeholder Coordination Plan is most applicable to project sizes of more than $10 million. The tool 14 Plan Standards is most appropriate for complex projects. But, the tool 15 In-Progress Design Workshops is most appropriate for moderate to complex projects.

Typically, tools that are appropriate for small and noncomplex projects are appropriate for larger and complex projects. However, tools appropriate for large and complex projects may not make sense with regard to costs and benefits for small, noncomplex projects.

Project Goal 3. Train Project Team Members

When CM-GC goals, approaches, processes, benefits, and changes have been communicated to agency personnel, the agency project manager needs to introduce training programs to cover these topics. Project team members need to understand their specific roles and responsibilities for implementing tools for CM-GC contract administration.

Project team members should be trained on the CM-GC contract administration tools they will be using and the details for their proper implementation. Training should extend to project managers, as well as to field and office staff. Training also should be provided to consultant staff representing the agency during contract administration as if they were part of the agency. Training may need to occur at various times during the life of a project as new individuals are onboarded or as weaknesses in tool implementation are observed. These weaknesses can include lack of tool use, incorrect tool use, or inconsistent tool use. Specific topics to include in the training to implement tools for CM-GC contract administration are

- Tool Purpose (Why is it used?),
- Tool Function (What does it do?),
- Tool Timeline (When is it implemented?), and
- Tool Resources (Who is involved?).

The use of new tools for CM-GC contract administration is effective only if tools are implemented properly throughout the life of the project. Training is the foundation for proper and consistent implementation of tools for CM-GC contract administration.

Project Goal 4. Test New Tools

An agency should test new tools for CM-GC contract administration before incorporating them. New tools can be tested on a pilot project to help team members analyze and understand each tool better and to determine how the tool can be customized to fit the agency's processes.

For example, 6 Co-Location of Key Personnel may occur daily in a physical location for agencies with a high volume of CM-GC projects in urban areas where engineers and contractors are located. However, an agency with many CM-GC projects in rural areas may allow co-location to happen through regular Internet meetings supplemented with weekly face-to-face meetings.

The agency can also test new tools in parallel with similar tools already in use. Such a side-by-side comparison of performance can facilitate the identification of strengths and weaknesses.

Project Goal 5. Evaluate Tool Performance

The agency project manager should evaluate project tool performance on a regular basis. Those evaluations should then be incorporated into the project team's "lessons learned" summary, typically at the end of the project. This step allows all team members to provide insight and perspectives on how the tools functioned and how they can be improved. This action ensures that the tools evolve if an agency's project delivery needs change. Regular evaluation for continuous improvement can help the tools perform to their maximum potential.

9.4 Agency Construction Manager–General Contractor Contract Administration Training

Training related to CM-GC delivery and tools for CM-GC contract administration can occur through formal training sessions, workshops, meetings, manuals, written materials, and informal interactions. CM-GC contract administration training will share knowledge with project personnel about roles and responsibilities, tool implementation, and documentation. Training should always distinguish CM-GC goals and processes from D-B-B, since D-B-B is the typical experience people will be bringing with them. Initial training will occur early in the project development. Additional training can be provided during later project phases as new team members join the project or as the need becomes apparent.

Time and effort are required to develop a good training event. An agenda designed to address training goals should be developed, and handout materials and visual aids should be gathered to support the agenda objectives. Experts in CM-GC contracting should be involved in delivering the training along with the agency CM-GC leaders and the CM-GC firm project manager. At the meeting or workshop, examples of cost models, open-book estimating, and cost–savings matrices can be presented and discussed. The iterative cost estimating process and price proposal negotiation process can also be reviewed.

All project team members, as well as agency management involved in approvals, should be invited to the training. Upper-level support for the training should be visible. All participants should understand that the organization's culture includes a long-term commitment to successful CM-GC contract administration.

Agency CM-GC manuals can be used to train agency staff and others to provide a uniform understanding of how the agency intends to implement CM-GC projects. When CM-GC

delivery is new within an agency, the agency project manager of a CM-GC project may need to meet with individuals within functional groups to provide information on CM-GC roles, responsibilities, and processes. CM-GC training should become increasingly more targeted for CM-GC delivery and to fine-tune tools for CM-GC contract administration based on the specific context of each project.

9.5 Summary

This chapter introduced the recommended approaches to integrating and implementing CM-GC concepts at both the organizational and project level. Establishing and achieving these implementation goals will assist in improving the agency's execution of CM-GC projects. To consistently achieve project success, agencies are encouraged to integrate and implement the concepts found in this guidebook and provide training to agency personnel and project stakeholders.

References and Bibliography

AASHTO. *AASHTO Guide to Quality in Preconstruction Engineering*, Washington, D.C., 2003.

AASHTO. *AASHTO Consultant Contracting Guide*, Washington, D.C., 2008a.

AASHTO. *AASHTO Guide for Design–Build Procurement*, Washington, D.C., 2008b.

AASHTO. *Practical Guide to Cost Estimating*, 1st Edition, Washington, D.C., 2013.

AASHTO. *AASHTO Partnering Handbook*, 2nd Edition (draft). Washington, D.C., 2017.

Alleman, D., A. Antoine, D. Papajohn, and K. Molenaar. Desired Versus Realized Benefits of Alternative Contracting Methods on Extreme Value Highway Projects. In *Proceedings of International Structural and Engineering Society: Resilient Structures and Sustainable Construction* (E. Pellicer, J. M. Adam, V. Yepes, A. Singh, and S. Yazdani, eds.), ISEC Press, Fargo, North Dakota, 2017.

Arizona Department of Transportation. *Design–Build Procurement and Administration Guide,* 3rd Edition. 2007. https://azdot.gov/docs/default-source/construction-group/designbuildguide.pdf?sfvrsn=0. Accessed February 10, 2018.

Arizona Department of Transportation. CMAR Method Is Beneficial for Certain Projects. May 22, 2013. https://www.azdot.gov/media/blog/posts/2013/05/22/cmar-method-is-beneficial-for-certain-projects. Accessed September 23, 2017.

Arizona Department of Transportation. *ADOT Construction Manager at Risk (CMAR), Process Guide,* 2nd Edition. September 2014. https://www.azdot.gov/business/standards-and-guidelines/guidelines. Accessed September 26, 2017.

California Department of Transportation. Preconstruction Services Contract State Route 99 Realignment, Construction Manager–General Contractor Services. n.d. https://dot.ca.gov/-/media/dot-media/programs/design/documents/f0005607-executed-psc-06-2ht101-a11y.pdf. Accessed February 15, 2020.

California Department of Transportation. *Quality Control Manual for Hot Mix Asphalt for the Quality Control Quality Assurance Process.* June 2009. http://www.dot.ca.gov/hq/construc/publications/qcqaman1.pdf. Accessed February 18, 2018.

California Department of Transportation. *Design–Build Demonstration Program Quality Manual Outline.* July 2013. http://www.dot.ca.gov/design/idd/db/sac50-5/rfp/03-2F21U4-Exhibit-2A-Quality-Manual-Template.pdf. Accessed February 12, 2017.

California Department of Transportation. Preconstruction Services Contract Interstate 215 Barton Road Interchange Reconstruction Project, Construction Manager/General Contractor Services. 2015. www.caltrans.ca.gov/hq/oppd/cmgc/awarded/SBd-215-Barton-PSC-Posted.pdf. Accessed August 29, 2017.

Capers, H., H. Ghara, K. C. Rehm, N. Boyd, T. Swanson, C. Swanwick, R. J. Healy, R. W. Dunne, and R. S. Watral. NCHRP Project 20-68A, Scan 09-01: Best Practices in Quality Control and Assurance in Design. Transportation Research Board, Washington, D.C., 2011. http://onlinepubs.trb.org/onlinepubs/nchrp/docs/nchrp20-68a_07-01.pdf. Accessed April 13, 2018.

Chung, H. W. *Understanding Quality Assurance in Construction: A Practical Guide to ISO 9000.* E & FN Spon, London, UK, 1999.

Colorado Department of Transportation. Project Delivery Selection Matrix. 2014. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build/pdsm. Accessed March 12, 2018.

Colorado Department of Transportation. *Construction Manager/General Contractor (CM/GC) Manual* (Appendix). 2015a. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC).* 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

Connecticut Department of Transportation. Construction Manager/General Contractor Procurement Guidance Document for the Walk Bridge Project. 2014. http://www.ct.gov/dot/lib/dot/documents/aec/ConnDOT_CMGC_Procurement_Guidance_Document.pdf. Accessed July 23, 2018.

Federal Register. Design–Build Contracting. December 10, 2002. https://www.gpo.gov/fdsys/pkg/FR-2002-12-10/pdf/02-30428.pdf. Accessed June 2, 2018.

Federal Register. Construction Manager/General Contractor Contracting. December 2, 2016. https://www.gpo.gov/fdsys/pkg/FR-2016-12-02/html/2016-28977.htm. Accessed June 24, 2018.

FHWA. *Use of Contractor Test Results in Acceptance Decisions.* Technical Advisory T6120.03. n.d. https://flh.fhwa.dot.gov/resources/construction/documents/contractor-qc-plans.pdf. Accessed July 22, 2019.

FHWA. *Contractor Quality Control Plans, Contractor Guidelines, and Example Quality Control Plan.* U.S. Department of Transportation, Washington, D.C. 1998. https://flh.fhwa.dot.gov/resources/construction/documents/contractor-qc-plans.pdf. Accessed February 18, 2018.

FHWA. *Planning and Environmental Linkages Partnering Agreement.* U.S. Department of Transportation. 2009. http://environment.fhwa.dot.gov/integ/final_signed_partnering_agreement_June09.pdf.

FHWA. *Guidance on QC/QA in Bridge Design in Response to NTSB Recommendation (H-08-17).* U.S. Department of Transportation. 2011. https://www.fhwa.dot.gov/bridge/h0817.pdf. Accessed April 14, 2018.

FHWA. *Construction Manager/General Contractor Contracting Final Rule.* 2016. https://www.federalregister.gov/documents/2016/12/02/2016-28977/construction-managergeneral-contractor-contracting. Accessed August 20, 2017.

FHWA. *Alternative Contracting Method Performance in U.S. Highway Construction.* FHWA-HRT-17-100. Washington, D.C. 2017a.

FHWA. EDC-2 Innovations (2013–2014). 2017b. https://www.fhwa.dot.gov/innovation/everydaycounts/edc-2.cfm. Accessed April 13, 2018.

FHWA. *Federal-Aid Program Administration.* 2018. https://www.fhwa.dot.gov/federalaid/stewardship/. Accessed August 20, 2018.

FHWA Minnesota Division and Minnesota Department of Transportation. *Stewardship & Oversight Agreement on Project Assumption and Program Oversight by and Between Federal Highway Administration, Minnesota Division and the State of Minnesota Department of Transportation.* 2015. https://www.fhwa.dot.gov/federalaid/stewardship/agreements/mn.pdf.

Florida Department of Transportation. *Plans Preparation Manual, Volume 1: Design Criteria and Process.* 2017. http://www.fdot.gov/roadway/ppmmanual/2017/Volume1/2017Volume1.pdf. Accessed February 11, 2018.

Ford, M. L. *NCHRP Web Document 39: Managing Change in State Departments of Transportation: Scan 7 of 8: Innovations in Public–Public Partnering and Relationship Building in State DOTs.* Transportation Research Board, Washington, D.C., 2001. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w39-7.pdf. Accessed April 13, 2018.

Georgia Department of Transportation. *Design–Build Manual.* Revision 4.2. 2016. http://www.dot.ga.gov/PS/DesignManuals/DesignGuides. Accessed November 25, 2017.

Gransberg, D. D., and J. S. Shane. *NCHRP Synthesis 402: Construction Manager-at-Risk Project Delivery for Highway Programs.* Transportation Research Board of the National Academies, Washington, D.C., 2010. https://dx.doi.org/10.17226/14350.

Gransberg, D. D., J. Datin, and K. R. Molenaar. *NCHRP Synthesis 376: Quality Assurance in Design–Build Projects.* Transportation Research Board of the National Academies, Washington D.C., 2008. https://dx.doi.org/10.17226/23222.

Gransberg, D. D., J. Shane, J. Schirholz, S. Anderson, A. Hessami, C. Lopez del Puerto, K. Strong, D. Pittenger, D., and J. McMinimee. NCHRP Project 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects, Transportation Research Board of the National Academies, Washington, D.C., 2013.

Hoyle, D. *ISO 9000 Quality Systems Handbook: Using the Standards as a Framework for Business Improvement,* 6th Edition, Elsevier, Oxford, UK, 2009.

International Partnering Institute. *Collaborative Partnering Best Practices Guide.* Livermore, CA, 2017.

Jie, Y., C. Nan Fu, and G. W. Raba. Implementation of a Web-Based Electronic Data Management System for the Construction Material Quality Assurance Program of a Highway Mega-Project. Presented at 85th Annual Meeting of the Transportation Research Board, Washington, D.C., 2006.

Lane, L. B. *NCHRP Synthesis 373: Multi-Disciplinary Teams in Context-Sensitive Solutions.* Transportation Research Board of the National Academies, Washington D.C., 2007. https://dx.doi.org/10.17226/23123.

Migliaccio, G. C., G. E. Gibson, and J. T. O'Connor. Procurement of Design–Build Services: Two-Phase Selection for Highway Projects. *Journal of Management in Engineering,* Vol. 25, No. 1, 2009. pp. 29–39.

Minchin, E., L. Ptschelinzew, G. C. Migliaccio, U. Gatti, K. Atkins, T. Warne, G. Hostetler, and S. Asiamah. *NCHRP Report 787: Guide for Design Management on Design–Build and Construction Manager/General Contractor Projects.* 2014. https://dx.doi.org/10.17226/22273.

Minnesota Department of Transportation. *Case Study Work Package #1: Early Piling Procurement.* n.d. www.dot.state.mn.us/winonabridge/docs/package1.pdf. Accessed July 30, 2017.

Minnesota Department of Transportation. *Draft CM/GC Interim Pricing (OPCC) Milestone Process,* Draft. 2013. www.dot.state.mn.us/const/tools/docs/cmgc-cost-estimating-process.docx. Accessed August 24, 2017.

Minnesota Department of Transportation. *Benefits of the Construction Manager/General Contractor (CMGC) Delivery Method.* 2015. http://www.dot.state.mn.us/winonabridge/docs/casestudies/casestudy8.pdf. Accessed December 21, 2017.

Minnesota Department of Transportation. *CM-GC Manual* (draft). 2016.

Molenaar, K., D. D. Gransberg, S. Scott, D. Downs, and R. Ellis. *Recommended AASHTO Design–Build Procurement Guide.* Transportation Research Board of the National Academies, Washington, D.C., 2005.

Molenaar, K. R., D. D. Gransberg, and D. N. Sillars. *NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction.* Transportation Research Board of the National Academies, Washington, D.C., 2015. https://dx.doi.org/10.17226/22128.

Nevada Department of Transportation. Partnering Program. n.d. https://www.nevadadot.com/doing-business/about-ndot/ndot-divisions/operations/construction/partnering-program. Accessed April 14, 2018.

Pennsylvania Department of Transportation. *Innovative Bidding Toolkit.* 2013. http://www.penndot.gov/_layouts/pa.penndot.formsandpubs/formsandpubs.aspx. Accessed September 17, 2017.

Sellwood Bridge Project, Multnomah County, Oregon. 2017. http://www.sellwoodbridge.org/. Accessed March 10, 2018.

Transportation Research Board. *Transportation Research Circular E-C137: Glossary of High Quality Assurance Terms.* Transportation Research Board of the National Academies, 2009. http://www.trb.org/Publications/Blurbs/162259.aspx. Accessed June 2, 2018.

University of Colorado Boulder. Next-Generation Transportation Construction Management. n.d. https://www.colorado.edu/tcm/. Accessed April 13, 2018.

Utah Department of Transportation. *Project Delivery Network.* 2015. http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:3140. Accessed October 1, 2017.

Utah Department of Transportation. Change Orders UDOT 08B-10. Revised August 7, 2017. https://www.udot.utah.gov/main/uconowner.gf?n=10539014823834013. Accessed July 23, 2018.

Value Engineering. *Federal Register*, Vol. 79, No. 172. September 5, 2014. https://www.gpo.gov/fdsys/pkg/FR-2014-09-05/pdf/2014-21020.pdf. Accessed March 4, 2018.

Washington State Department of Transportation. I-405/NE 6th Street to I-5 Widening and Express Toll Lane Project, Request for Proposal. July 25, 2011. Appendix A, Z2. http://www.wsdot.wa.gov/biz/contaa/ProjectContracts/DESIGNBUILDCONTRACTS/NE%206TH%20ST%20TO%20I-5/Default.htm. Accessed December 16, 2017.

Washington State Department of Transportation. *Project Delivery Method Selection Guidance*, February 12, 2016. https://www.wsdot.wa.gov/NR/rdonlyres/F7691703-FB89-44E5-BD9A-EE10F4B288CB/0/FinalPDMSGandAppendixAREV2_12_16.pdf. Accessed March 12, 2018.

Washington State Department of Transportation. Payment Checklist. Email correspondence. January 3, 2018.

Glossary

Acceptance: The process of deciding, through inspection, whether to accept or reject a product, including what pay factor to apply. [Where contractor test results are used in the agency's acceptance decision, the acceptance process includes contractor testing, agency verification, and possible dispute resolution (Transportation Research Board 2009).]

Alternative contracting method (ACM): A system used—instead of the traditional design–bid–build method—to procure those parties, materials, lands, and means necessary to execute the completion of a construction project (Minchin et al. 2014). Common alternative contracting methods include design–build (D-B) and construction manager–general contractor (CM/GC) (FHWA 2018). Other synonymous terms are innovative contracting method and alternative project delivery method.

Alternative Technical Concepts (ATC): The design–builder's proposed changes to agency-supplied basic configurations, project scope, design, or construction criteria. These changes provide a solution that is equal to or better than the requirements in the RFP. ATCs provide flexibility to the proposers in order to enhance innovation and achieve efficiency (AASHTO 2008b).

Best Value: A procurement process where price and other key factors are considered in the evaluation and selection process (AASHTO 2008b).

Construction Manager–General Contractor (CM-GC): A project delivery system that entails a commitment by the construction manager to deliver the project within a guaranteed maximum price (GMP), in most cases. The construction manager acts as consultant to the owner in the development and design phases and as the equivalent of a general contractor during the construction phase. [When a construction manager is bound to a GMP, the general nature of the working relationship is changed. In addition to acting in the owner's interest, the construction manager must manage and control construction costs to not exceed the GMP, which would be a financial loss to the construction manager (Transportation Research Board 2009).]

Design–bid–build (D-B-B): A project delivery system in which the design is completed either by in-house professional engineering staff or a design consultant before the construction contract is advertised. [The D-B-B method is sometimes referred to as the traditional method (Transportation Research Board 2009).]

Design–build (D-B): A project delivery system in which both the design and the construction of the project are simultaneously awarded to a single entity. [The main advantage of the D-B method is that it can decrease project delivery time (Transportation Research Board 2009).]

Dispute resolution: Processes that are used to resolve a conflict, dispute or claim. The traditional method of dispute resolution includes litigation. Dispute resolution techniques that include

other techniques—such as arbitration, mediation, and negotiation—may also be referred to as alternative dispute resolution or appropriate dispute resolution (ADR). ADR techniques can be either binding (e.g., arbitration) or nonbinding (e.g., mediation). Also called conflict resolution.

Early work package (EWP): A work package, which—in this context—typically includes a design package, scope documents, and a guaranteed maximum price construction contract that is released for a notice to proceed prior to all the design work for the overall project being complete. Multiple early work packages can be implemented to complete the overall project (Alleman et al. 2017).

Guaranteed maximum price (GMP): Also known as "construction agreed-upon price" (CAP), is a pricing provision in which the CM-GC stipulates a target price above which the owner is not liable for payment if the project's scope does not change after the target price is established (Gransberg et al. 2013).

Independent assurance (IA): A management tool that requires a third party—not directly responsible for process control or acceptance—to provide an independent assessment of the product or the reliability of test results, or both, obtained from process control and acceptance. [The results of independent assurance tests are not to be used as a basis of product acceptance. Independent assurance gives management an unbiased evaluation of its construction QA system and provides assurance of the effectiveness and proficiency of quality control and acceptance. (Transportation Research Board 2009).]

Inspection: The act of examining, measuring, or testing to determine the degree of compliance with requirements [and to assess the amount of work completed (Transportation Research Board 2009).]

Partnering: A structured process that creates an owner–contractor relationship focused on achieving mutually beneficial goals (Transportation Research Board 2009).

Pre-Award: A period of time in the life of a project prior to the establishment of a signed contract that can include activities related to contract development, issuance of the request for proposal, and bid evaluations. For D-B, this is prior to signing the D-B contract. For CM-GC, this is prior to signing the preconstruction services contract.

Preconstruction services: These tasks are performed by the contractor for the agency and can include almost anything the agency desires from its CM-GC contractor. The range of possibilities include typical estimating and scheduling assistance, managing public relations, and preparing and submitting environmental permits (Gransberg et al. 2013).

Post-Award: A period of time in the life of a project after the establishment of a signed contract and can include activities related to project execution, administration, and closeout. For D-B, this period is after signing the D-B contract. For CM-GC, this period is after signing the preconstruction services contract.

Qualifications-based selection: A process of procuring a service provider—such as a designer or contractor—using experience and ability in the decision-making criteria. An RFQ is submitted by the agency, followed by a statement of qualifications provided by the designer or contractor. The RFQ typically requires an organizational chart, corporate project experience, key personnel experience, required management plans, and other submittal requirements (adapted from Gransberg et al. 2013).

Quality assurance (QA): All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. [QA addresses the overall problem of obtaining the quality of a service, product, or facility in the most efficient, economical,

and satisfactory manner possible. Within this broad context, QA involves continued evaluation of the activities of planning, design, development of plans and specifications, advertising and awarding of contracts, construction, maintenance, and the interactions of these activities (Transportation Research Board 2009).]

Quality control (QC): Those QA actions and considerations necessary to assess and adjust production and construction processes so as to control the level of quality being produced in the end product (Transportation Research Board 2009).

Request for Proposal (RFP): Advertisement requesting proposals for work in accordance with the requirements outlined in the project criteria package (AASHTO 2008b).

Request for Qualifications (RFQ): Advertisement requesting statements of qualifications. It contains at least the desired minimum qualifications of the design–builder (or CM-GC), a scope of work statement, and general project requirements (AASHTO 2008b).

Strategy: A plan of action for accomplishing specific goals. In this guidebook, strategies address goals relating to CM-GC administration, such as team alignment, construction quality, or construction efficiency.

Tool: A tool is used to perform an operation. In this guidebook, it is a tactic or process relating to CM-GC contract administration, such as checklists, spreadsheets, guidelines, and structured meetings.

Validation: The process of confirming the soundness or effectiveness of a product (such as a model, a program, or specifications) thereby indicating official sanction. [The validation of a product often includes the verification of test results (Transportation Research Board 2009).]

Value engineering: The systematic review by qualified agency and/or contractor personnel of a project, product, or process so as to improve performance, quality, safety, and life-cycle costs (Transportation Research Board 2009).

Verification: The process of testing the truth—or of determining the accuracy of test results—by examining the data or providing objective evidence, or both. [Verification sampling and testing may be part of an independent assurance program (to verify contractor QC testing or agency acceptance) or part of an acceptance program (to verify contractor testing used in the agency's acceptance decision) (Transportation Research Board 2009).]

Work package: Developed primarily by breaking down the project scope of work into bid packages that include material, labor, and equipment and by reviewing the design documents that go with each package to ensure that sufficient information is contained in them to draw competitive pricing (Gransberg et al. 2013).

APPENDIX A

Contract Administration Tools

This appendix contains descriptions of all the contract administration tools discussed in this guidebook. Tools may be used in one or more phases, as indicated in Table A.1. These tools were identified through CM-GC project case studies with numerous agencies and a state-of-practice review of all existing state DOT CM-GC guidebooks. Each tool description is organized according to the format listed here:

- Tool number and name
  - The number is for quick identification of the tool in this guidebook, and the name is intended to reveal the nature of the tool.
- Brief description
  - Includes one or two sentences to give the reader a quick overview of what to expect in the remaining description.
- What is it?
  - An expanded description of the tool.
- Why use it?
  - Explains the purpose of the tool and lists its potential benefits. This section also discusses the contract administration strategies that the tool addresses by referring back to Chapter 2. The five contract administration strategies are each identified with their unique graphics.


ALIGNMENT


SCOPE


PRECONSTRUCTION QUALITY


CONSTRUCTION QUALITY


CONSTRUCTION EFFICIENCY

- When to use it?
  - This section includes a table that indicates the contract administration phase(s) in which the tool could be used. The table also summarizes guidance from as many as 16 experts—including industry and academic professionals, as well as agency leaders and practitioners—who reviewed each tool. These CM-GC experts provided feedback on the tools' usefulness (e.g., recommended, considered case by case, or not recommended) for various CM-GC project sizes (e.g., <$10 million, $10 million–$50 million, and >$50 million) and complexities (e.g., noncomplex, moderately complex, and complex). Note that "recommended" does not mean required; an agency should use its own discretion on whether a tool is appropriate for a particular project.
- How to use it?
  - This section provides information about how to implement the tool successfully in your project.
- Synthesis of Examples
  - This section summarizes tips and implementation guidance found when analyzing the case study project examples and is included when applicable.

Table A.1. Tools for agency use in construction manager–general contractor contract administration.

Tools for Construction Manager–General Contractor Contract Administration	Contract Administration Phases					Page Number
	Alignment	Design	Preconstruction	Construction	Closeout	
1 Kickoff Meeting	✓					50
2 Roles and Responsibilities	✓					57
3 Glossary of Terms	✓					62
4 External Stakeholder Coordination Plan	✓	✓				64
5 Regulatory Agency Partnering	✓	✓	✓			68
6 Co-Location of Key Personnel	✓	✓	✓			71
7 Construction Manager–General Contractor Management Fee Table	✓		✓	✓	✓	74
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓	77
9 Continuity of Team Members	✓	✓	✓	✓	✓	80
10 FHWA Involvement Overview	✓	✓	✓	✓	✓	83
11 Permit Commitment Database	✓	✓	✓	✓	✓	88
12 Discipline Task Force		✓				91
13 Independent Party Design Review		✓				93
14 Plan Standards		✓	✓			95
15 In-Progress Design Workshops		✓	✓			98
16 Deviations from Agency Standards		✓	✓			101
17 Over-the-Shoulder Reviews		✓	✓			104
18 Open-Book Estimating		✓	✓	✓		107
19 Public Announcements		✓	✓	✓	✓	113
20 Delegation of Authority		✓	✓	✓	✓	119
21 Cost-Comparison Spreadsheet			✓			122
22 Cost-Modeling Approach			✓			126
23 Construction Manager–General Contractor Bid Validation			✓			131
24 Independent Cost Estimator			✓			137
25 Cost–Savings Matrix			✓			140
26 Opinion of Probable Construction Cost Process			✓			145
27 Risk Pools			✓	✓		153
28 Contractor-Controlled Quality Control Testing				✓		158
29 Contractor Involvement in Establishing Quality Control Standards				✓		161
30 Real-Time Electronic Quality Management Information				✓		163
31 Witness and Hold Points				✓		166
32 Payment Checklist				✓	✓	169

- Examples
  - The examples are real projects that have used the tools. They include text and tables that show how an agency used the tool on a recent project. Sometimes multiple examples are provided to show alternative ways of implementing a tool. This variety is intended to encourage the reader to adapt the basic tool to meet their own agency and project needs.
- References
  - This section provides a list of written and web resources where the reader can find more information about the tool. Since some of these tools are newer, and CM-GC is relatively recent to highway agencies, there may not be many resources beyond this guidebook.

1 Kickoff Meeting

This meeting introduces the project participants to the project and to each other. Aspects relevant to a CM-GC project are discussed, including roles and responsibilities, quality management processes, review processes, schedule, schedule of values, and payment processes.

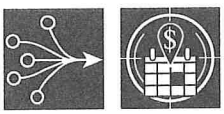
What Is It?

The kickoff meeting is the first team meeting. For a CM-GC project, it is an opportunity to introduce the CM-GC firm to the agency and design team members. Other project stakeholders who may participate include FHWA (if it is a federally funded project) or representatives from other entities that are associated with the project, such as cities and counties, utility companies, and regulatory agencies. Discussion topics typically include a project overview with an emphasis on project challenges and constraints. Even when team members are experienced with CM-GC, it is important to review the changed roles and responsibilities associated with the CM-GC process to help align everyone's understanding. QM processes, review processes, time constraints, potential innovations, risks, and pricing may also be discussed.

Why Use It?

The kickoff meeting provides an opportunity to create early team alignment around project goals and processes. It creates a time and a place for team members to discuss how they will execute the project as a CM-GC. The meeting is an opportunity to set up a project framework that assists the team in being successful. For example, the team can develop and communicate project processes, such as ensuring design quality. For federally funded projects, the team can discuss FHWA involvement. Regulatory constraints and permit requirements can also be reviewed.

Potential benefits include setting the stage for construction input in design to encourage constructability, innovation, and risk mitigation, leading to flexibility during design and construction. Other benefits include developing a basis for a shared risk allocation and facilitating the resolution of third-party issues (e.g., utilities or permits).



A kickoff meeting addresses the Alignment Strategy and the Scope Strategy. It helps establish clear project goals and create productive relationships within the agency and between the agency and CM-GC team members. The meeting allows project stakeholders to begin communication during the early stages of the project, developing effective lines of communication and working relationships early on. The meeting also helps ensure that the project scope—as described in the RFP—and responsibilities are understood and agreed upon by all parties. During the meeting, any discrepancies or areas of uncertainty can be identified and resolved.

When to Use It?

The kickoff meeting should take place a few weeks after the notice to proceed (NTP) of the CM-GC project professional services contract. Even when project team members have worked on CM-GC projects, the kickoff meeting is valuable for generating a common understanding of *this* project's team so that team members are operating on a commonly agreed-upon process rather than assumptions. Kickoff meetings are recommended for projects of all sizes and complexities (Table A.2).

Table A.2. Recommended uses for kickoff meeting.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
1 Kickoff Meeting	✓					●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

The agency and CM-GC project manager plan the 1-day workshop together. Everyone involved in the project from the design, construction, and agency sides should be invited. Documents should be prepared in advance to present the scope of work, potential project issues, proposed schedule, proposed schedule of values, and any other relevant tasks. A meeting summary should be prepared and distributed afterwards. A partnering meeting can be paired with the kickoff meeting or held separately.

Synthesis of Examples

The kickoff meeting brings together project team members from the agency, the CM-GC firm, the design consultants, and outside stakeholders, such as FHWA, the Army Corps of Engineers, U.S. Fish and Wildlife Service, local jurisdictions, and utility representatives. Agency personnel include the CM-GC program liaison, the project manager, resident engineer, field and office personnel, discipline reviewers, inspectors, and other project team members. Team members from the agency, consultants, and the CM-GC firm are expected to remain with the project through all project phases.

The facilitator of the kickoff meeting varies. It could be the agency's CM-GC program manager or project manager, or it could be co-led with the CM-GC project manager. The kickoff meeting may last 4 to 8 hours or longer, depending on project complexity. Typical items on the agenda for a kickoff meeting include the following:

- Provide introductions.
- Identify key participants in the delivery process and discuss their roles and responsibilities.
- Introduce key elements of the scope and innovations.
- Provide project background information, such as current status; goals; right-of-way acquisition; available studies and reports; and unique issues, including environmental concerns or utility conflicts.
- Discuss the overall design and construction schedules, major activities, milestones, and phasing.
- Discuss the project budget, schedule of values, and payment processing.
- Discuss communications protocol, team meetings, change management processes, and issue resolution processes.
- Discuss design reviews.
- Discuss potential CM-GC risks and possible mitigation strategies.
- Discuss partnering meeting objectives, if combined with the kickoff meeting.

Example 1

I-215 Barton Road Interchange Project, California Department of Transportation (Caltrans)

Caltrans scheduled a project team kickoff meeting for the Barton Road project after the selection of the CM-GC. The meeting provided an opportunity for the design team to present multiple aspects of the project to the CM-GC team members. They also reviewed the roles, responsibilities, and the process associated with the CM-GC delivery method.

Task 1. Project Team Kickoff Workshop

The Construction Manager shall collaboratively work with the department Project Manager to plan, attend, and actively participate as a member of the Project Team in the Project Team kickoff workshop, to be led by the department. The Project Team kickoff workshop may include discussion of the following:

1. Introduction to the Project, the CM-GC delivery method, the partnering process, and the Project stakeholders
2. Presentation of Project elements and the Project scope
   a. Project status, goals, objectives, and so on
   b. Project information, including relevant plans, specifications, studies, and reports
3. Project schedule and major milestones
   a. Project Team meetings
   b. Major Project activities
4. Identification of roles and responsibilities for the Project Team
   a. Construction Manager–General Contractor Program Team
   b. Project Development Team
   c. Construction Manager
   d. Independent Cost Estimator
5. Process for design input
   a. Innovation
   b. Project Engineer's needs
6. Communications protocol and plan
7. Identification of change-management process
8. Initial discussions on
   a. Cost–pricing development
   b. Project risks identification

Assumptions: The Project Manager, Project Construction Manager, Preconstruction Manager, CM-GC Specialist, and two additional key personnel—as appropriate with consultation with the department Project Manager—shall participate in one (1) Project Team kickoff workshop, which will last up to 8 hours during the course of 1 business day.

Example 2

Winona Bridge Project, Minnesota Department of Transportation (Minnesota DOT)

Minnesota DOT used a project team kickoff meeting (see following agenda) for the Winona Bridge Project—Minnesota's first CM-GC project—to introduce the roles of team members on a project using the CM-GC delivery method. The project team kickoff meeting was also used to review Minnesota DOT's CM-GC processes for risk, OPCC, and cost model development. They also discussed potential work packaging to be used with this CM-GC project.

S.P. 8503-46 Winona Bridge Project (TH 43)
CM/GC Kickoff Meeting
AGENDA
[Minnesota DOT] Bridge Office in Oakdale
8 a.m.–5 p.m.
01/15/14

Introduction of Winona Project—Minnesota's 1st CM-GC Project

1. Introduction of [Minnesota DOT], FHWA, and Consultant Teams/Roles
   - [Minnesota DOT]
     - Design and Construction Organizational Charts
   - FHWA
   - Consultants
     - Bridge 85851 and Roadway
     - Bridge 85851 Peer Review
     - Bridge 5900
     - Bridge 5900 Peer Review
     - Independent Cost Estimate
     - Risk and Owner's Estimate
   - CM-GC Contractor
2. General Overview of Project
   - Geometric Layout
     - Design Exceptions—FHWA Mitigations
   - Bridge 85851
     - Preliminary Bridge Plans
   - Bridge 5900
     - Preliminary Bridge Plans
   - CM-GC Work Package Phasing
     - WP 1 and 1A
     - WP 2
     - WP 3
     - Potential Early Work Package
       - Funding
       - Approvals
         - [Minnesota DOT] Internal
         - FHWA

(continued on next page)

    - Constraints
        - Finding of No Significant Impact
        - Environmental Permitting
        - Design Package Preparation
        - Risk Analysis
        - OPCC and Guaranteed Maximum Price (GMP) Processes
        - Severability
3. Status of Project Elements
    - Hydraulics Analysis
    - Scour Analysis
    - Vessel Impact Study
    - Visual Quality Committee/Manual
    - Foundations Analysis
    - Environmental Assessment
    - Environmental Permitting
    - Right of Way
    - Utilities
    - Construction Staging/Maintenance of Traffic
    - Project Funding
        - $142 million Chapter 152 Maximum Price Cap
        - Not Including Right of Way
    - Public Relations
    - Other Areas Identified During Meeting
4. Goals and Objectives
    - [Minnesota DOT]
        - Successful CM-GC Procurement
        - Track Lessons Learned and Value of CM-GC
        - Start Work on Bridge 85851 in July 2014 (if not sooner)
        - Meet the $142 Maximum Price Cap of Chapter 152 (not including right of way)
        - Have Fun Along the Way
    - Working Together
        - Solve Problems
        - Raise Issues
        - No Finger Pointing
        - No Marketing
        - Work as an Integrated Team Across All Companies
        - Help the Entire Project Team Succeed
    - Goals from Project Partners
5. CM-GC Process/Risk Analysis—Overview
    - [Minnesota DOT] CM-GC Process Papers
    - Project Processes
        - Risk
    - Group Discussion of OPCC and GMP Processes
        - Design and Special Provision Development
        - Risk Analysis
        - Reconciliation Meetings
    - Group Discussion of CM-GC Cost Model Development and Independent Cost Estimator Integration with Team
        - Separate Meetings to Work on These Important Aspects?

Example 3

I-70 Vail Underpass Project, Colorado Department of Transportation (Colorado DOT)

Colorado DOT used a project team kickoff meeting for the I-70 Vail Underpass Project. The meeting began by reviewing some partnering principles. The kickoff meeting also included a review of team member roles on a CM-GC project and the CM-GC processes for risk, cost model, OPCC, design review, cost model development, and CM-GC work package phasing.

Meeting Agenda
October 20, 2014
CM-GC Kickoff Meeting

1. Introductions
   Partnering
   - Partnering Objectives
   - Roles, Responsibilities, Communication, and Documentation
   - Issue–Conflict Resolution Matrix
   - Identification of Project Risks/Goals
   - Agreement

   CM-GC Kickoff Meeting
2. Project Status/Updates
   a. Project Goals
   b. Identify Stakeholders
   c. Project Budget
   d. Design Schedule Review
3. Environmental Clearance/Schedule
4. Right-of-Way Acquisition Schedule
   a. Right-of-Way Public Relations in April 2015
   b. Acquisitions Through April 2016
5. Utility Relocation Schedule
   a. Temporary/Permanent Relocations by General Contractor
6. Context Sensitive Solutions
   a. Monthly Project Leadership Team (PLT) Meetings – 3rd Friday of the Month
7. Roles and Responsibilities Matrix
8. Schedule
   a. Deliverables
   b. Meetings
      i. Weekly/Bi-Weekly Meetings
      ii. Cost Model Meeting, Field Inspection Review (FIR) Level, Opinion of Probable Construction Cost (OPCC) #1 Submittal
      iii. Risk Assessment Meeting
      iv. Final Office Review (FOR) Meeting
   c. Construction Agreed upon Price (CAP) Negotiations/Long Lead Time Procurement (LLTP) Items
9. Risk Management Plan/Risk Register
   a Initial Risk Register
   b. Schedule

(continued on next page)

10. Cost Model
    a. Cost Model Approach/Elements
    b. OPCCs—FIR, FOR, Plans Specifications and Estimate (PS&E) Level
    c. Schedule
11. Design Review
    a. Status–Action Item Matrix
    b. FIR-Level Design Review—Project Schedule, Constructability, Innovations, and Phasing
    c. Process for Innovation/Value Engineering Ideas
12 Phasing
    a. Schedule and Milestones
    b. Guaranteed Maximum Price (GMP) Schedule
13. Value Engineering Workshop [if applicable]
14. Upcoming Meeting/Next Steps
    a. Cost Model Meeting/FIR-Level OPCC
    b. Risk Assessment Meeting

References

California Department of Transportation. Preconstruction Services Contract State Route 99 Realignment, Construction Manager–General Contractor Services. n.d. https://dot.ca.gov/-/media/dot-media/programs/design/documents/f0005607-executed-psc-06-2ht101-a11y.pdf. Accessed February 15, 2020.

California Department of Transportation. Preconstruction Services Contract Interstate 215 Barton Road Interchange Reconstruction Project, Construction Manager/General Contractor Services. 2015. www.caltrans.ca.gov/hq/oppd/cmgc/awarded/SBd-215-Barton-PSC-Posted.pdf. Accessed August 29, 2017.

Georgia Department of Transportation. *Design–Build Manual*, Revision 4.2. 2016. http://www.dot.ga.gov/PS/DesignManuals/DesignGuides. Accessed November 25, 2017.

Minnesota Department of Transportation. *CM-GC Manual* (draft). 2016.

2 Roles and Responsibilities

This tool is a description of roles and responsibilities for the CM-GC.

What Is It?

Clearly defining the roles and responsibilities of project participants in alternative contracting methods is a significant aspect of defining each participant's expected scope of work. It could take the form of a table or a list. When parties share responsibility, primary, secondary, and collaborative responsibility may be indicated for the contractor, designer, agency, or other entity. This document can also be referred to as a Responsible, Accountable, Consulted, and Informed (RACI) chart (Figure A.1). The responsible person performs the activity, the accountable person makes the decision, the consulted person provides feedback, and the informed person receives updates.

Why Use It?

Defined roles and responsibilities can help clarify who is involved in a project and who is responsible for various activities. This can facilitate better understanding of project expectations between the contractor and designer. It also helps ensure that each task has a team member taking responsibility for it. Responsibility is also associated with risk, so it helps clarify who owns which risk.

RACI Chart (Roles and Responsibilities Matrix)

Process Name / Description: *Sample Project*

Created On: *1-Jul-18* Revision: *None*

Created by: *Project Manager*

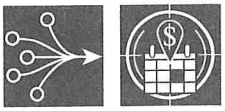
	Res. Engr	Distr. Engr.	Utility	ROW	Project Mgr
Task 1	C	-	-	-	R
Task 2	I	-	-	-	R
Task 3	A	I	I	-	R
Task 4	I	I	-	-	R
Task 5	I	I	R	I	I
Task 6	I	-	A	R	I
Task 7	A	I	I	-	R

R = Responsible, A = Accountable, C = Consulted, I = Informed

Figure A.1. Sample RACI chart.

Defining roles and responsibilities helps the contractor better quantify the level of effort and costs of work the contractor is responsible for. Similarly, it helps the agency identify tasks it will be undertaking for the project so it can plan for adequate resources to perform those tasks.

The potential benefits include cost savings, schedule acceleration, and shared risk allocation.



This tool addresses the Alignment Strategy and the Scope Strategy. The Scope Strategy includes a clear understanding of responsibilities and alignment, building toward productive relationships as team members fulfill their responsibilities.

When to Use It?

A clarification of roles and responsibilities is included in the RFQ, RFP, and preconstruction and construction contracts. This tool is recommended for projects of all sizes and for moderately complex to complex projects (Table A.3). It can be considered for use for noncomplex projects, as needed.

How to Use It?

The agency defines roles and responsibilities that can be summarized in a matrix to include in the RFQ and RFP. This way, all proposers are working off the same assumptions regarding roles and responsibilities. The agency and the selected contractor update the roles and responsibilities during negotiations of the preconstruction and construction contracts. One role is the CM-GC champion, who trains new team members on the distinctive CM-GC aspects of the project and keeps the team on track with applying the CM-GC process throughout the project. Another role is the CM-GC document specialist who serves as the agency's point of contact to receive, distribute, store, and organize project documents. The document specialist also reminds the consultant, contractor, and agency staff which documents are needed and by when and which reviews are needed and by when. Upper management support for a CM-GC project is critical for success. Therefore, the role of upper management is to support CM-GC projects and processes tangibly and visibly; for example, with CM-GC training and the appropriate level of staffing. Frequently, CM-GC projects are moving on fast schedules. Therefore, review times become critical. Reviewers must be made aware of the contractual review times, which are frequently shorter than standard review times. Also, over-the-shoulder reviews must be attended by reviewers who are authorized to make project decisions to keep the design advancing. For projects with performance specifications, reviewers must understand their role in checking that performance specifications are met and avoid introducing their own preferences into the review comments.

Table A.3. Recommended uses for roles and responsibilities.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
2 Roles and Responsibilities	✓					◗	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Synthesis of Examples

Clearly defining each project participant's roles and responsibilities communicates the expectation for each party, which ultimately improves the overall effectiveness of the project. How this information is conveyed takes many formats. A very general approach is the RACI chart, which identifies which party is responsible, accountable, consulted, or informed for different project responsibilities. Other formats use a variation of this approach, such as defining which party has the primary, secondary, or no responsibility, or simply identifying which party is or is not responsible. Some agencies develop a responsibility chart that is released with a project's RFP so that outside consultants can plan accordingly when submitting their bid for a project. Other agencies develop responsibility charts that are used for internal control purposes. Finally, responsibility charts can be used to define roles and responsibilities for an overall project or for specific phases of a project, depending on the project's overall complexity.

Example 1

Utah Department of Transportation (Utah DOT) Project Delivery Network

The preconstruction roles and responsibilities matrix is included in the Utah DOT *Project Delivery Network*, Version 1.12 (2015). The following example lists activities associated with geometric design. The project manager, designer, CM-GC, and independent cost estimator are listed in columns and marked with a check when each holds responsibility for an activity.

(continued on next page)

2F3 CMGC Geometry OPCC Estimate (back to table)

Overview

Produce a project cost estimate based on the Geometry Review Package.

Deliverables

- ☐ Bid Item List
- ☐ Reconciled Quantities
- ☐ Opinion of Probable Construction Cost Estimate
- ☐ Estimating Assumptions Document

Deliverable	Task	Responsible Party			
		Activity Leader			
		Project Manager	Designer	CMGC Contractor	ICE
Bid Item List	▪ Generate a list of bid items		X		
Reconciled Quantities	▪ Perform Quantity Take-offs for bid items		X	X	X
	▪ Meet to Reconcile Quantities	X	X	X	X
Estimating Assumptions Document	▪ Document the basis for item pricing		X	X	X
Opinion of Probable Construction Cost Estimate	▪ Provide pricing for bid items		X	X	X

Generate a List of Bid Items and Associated Quantities

The Designer generates a list of bid items from current level of design.

Perform Quantity Take-offs for Bid Items

Utilize various tools and methods to perform take-offs from design for bid item quantities.

Meet to Reconcile Quantities

Review, compare, and identify differences between quantities from each team. Discuss and eliminate differences to arrive at an agreement on all bid item quantities.

Document the Basis for Item Pricing

Each team documents their understanding and assumptions for all bid items and allocation of other general costs.

Provide Pricing for Bid Items

Each team provides pricing information into the pricing form.

Example 2

Colorado Department of Transportation *CM-GC Manual*

Colorado DOT has created the following matrix—included in Appendix A of their CM-GC manual—that shows the roles and responsibilities of the parties involved during the preconstruction phase.

APPENDIX A: PRECONSTRUCTION ROLES AND RESPONSIBILITIES MATRIX

CONSTRUCTION MANAGEMENT SERVICES	REQUIRED OF CONTRACTOR	REQUIRED OF DESIGN CONSULTANT	REQUIRED OF CDOT/ OTHERS
PHASE: PRE-CONSTRUCTION			
INITIAL PROJECT SCOPING MEETING (WORKSHOP)			
A. CMGC AND PARTNERING INTRO SESSION			
B. PROJECT SITE VISIT AND INSPECTION			
C. PROJECT STATUS, GOALS, ELEMENTS, OBJECTIVES, DESIGN SCHEDULE REVIEW			
D. INDENTIFY PROJECT RISKS AND DEVELOP INITIAL RISK MANAGEMENT PLAN AND RISK REGISTER			
E. REVIEW APPLICABLE ENVIRONMENTAL DOCUMENTS (ROD, FONSI, ETC.)			
F. INDEPENDENT DESIGN AND AS-BUILT REVIEW			
G. DEVELOP PROJECT SCHEDULE AND TASKS			
H. SCHEDULE BI-WEEKLY PROGRESS, FIR, FOR, AND MILESTONES MEETINGS			
I. IDENTIFY DESIGN CRITERIA			
J. DISCUSSION OF POSSIBLE EARLY DELIVERY AND LONG LEAD TIME ITEMS			
K. ANALYSIS OF PROJECT PHASING AND MULTIPLE PS&E PACKAGES			
L. DEVELOP DOCUMENT REVIEW AND NAMING CONVENTION STANDARDS			
M. QUESTION AND ANSWER SESSION			
PROGRESS MEETINGS			
A. CDOT/PM, C/PM, CMGC/PM			
B. PROJECT MEETING MINUTES			

The managers and team members will meet periodically as required (typically at two-week intervals). These progress meetings will be used to coordinate and track the work effort and resolve problems. The meetings will review the following:

- Activities required to be complete since last meeting (Action Items)
- Problems and challenges encountered/anticipated and potential solutions
- Project Schedule Updates (Design and Construction)
- Action Items
- Coordination and communication required with:
  - Team Members
  - CDOT Specialty Units
  - Other

The CDOT/PM will provide meeting minutes that include details discussed, notes, and all action items relating to the meeting within one week of the meeting.

References

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC)*. 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

Utah Department of Transportation. *Project Delivery Network*. 2015. http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:3140. Accessed October 1, 2017.

3 Glossary of Terms

A glossary of terms provides definitions of terms related to alternative contracting method activities.

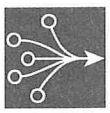
What Is It?

A glossary of terms is a collection of words and phrases related to activities associated with CM-GC. The glossary provides context and definitions for the terms that are not used in a traditional D-B-B project.

Why Use It?

A glossary of terms facilitates communication because it provides team members with a common vocabulary and understanding of key CM-GC terms. A shared understanding of terms is initially helpful for firms proposing on CM-GC projects and, more importantly, it helps ensure that the whole project team is aligned once the CM-GC firm has been selected. A glossary supports correct interpretation of project communication during all phases of the project, which builds team unity and cooperation. A project glossary also minimizes misunderstandings that can cause unnecessary problems and tension between project team members.

Potential benefits of this tool include aligning project stakeholders so that everyone involved in the project is speaking the same language. Even when team members are experienced with CM-GC, it is important to review the agency's—or project's—glossary of terms to help align everyone's understanding.


ALIGNMENT

A glossary of terms addresses the Alignment Strategy. It helps establish a clear terminology and creates clear expectations between the agency, consultants, and CM-GC team members. The glossary helps ensure that the project scope—as described in the RFP—and responsibilities are clearly understood by all parties.

When to Use It?

A glossary of terms is recommended for projects of all sizes and complexities (Table A.4).

How to Use It?

It is useful to include a glossary of terms in the RFQ and RFP so that firms will have a more accurate understanding of the stated scope of work that is being requested by the agency.

Table A.4. Recommended uses for glossary of terms.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
3 Glossary of Terms	✓					●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Similarly, the glossary can be included in the preconstruction services contract and the construction contract.

Synthesis of Examples

Examples of terms that can be included in a CM-GC project glossary can be found in this guidebook's glossary, which follows References and Bibliography. Some agencies, such as Caltrans, include a glossary of terms in the contracts. Other agencies, such as the Minnesota DOT, have included the glossary in their organization's CM-GC manual. Variations of this tool include agencies dividing the glossary into categories or sections, such as Design, Cost, Schedule, and Administrative.

References

California Department of Transportation. Preconstruction Services Contract Interstate 215 Barton Road Interchange Reconstruction Project, Construction Manager/General Contractor Services. 2015. www.caltrans.ca.gov/hq/oppd/cmgc/awarded/SBd-215-Barton-PSC-Posted.pdf. Accessed August 29, 2017.

Pennsylvania Department of Transportation. *Innovative Bidding Toolkit.* 2013. http://www.penndot.gov/_layouts/pa.penndot.formsandpubs/formsandpubs.aspx. Accessed September 17, 2017.

4 External Stakeholder Coordination Plan

This table identifies which external stakeholders to involve at various project milestones. It ensures that accurate information is conveyed and that stakeholder concerns are considered.

What Is It?

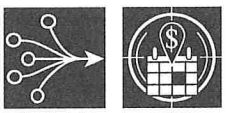
This tool provides a plan that outlines stakeholder interaction. The timing of interactions is predetermined, which helps prevent key milestones from passing without adequate interaction with stakeholders. The plan also describes who the relevant external stakeholders are for various milestone activities. This ensures that the appropriate people are being contacted about the right topics. The plan also identifies who is responsible for coordinating each particular milestone. The goal for each stakeholder-coordination event is stated in the plan so the team can develop interactions that meet those goals.

Why Use It?

Good communication between the project team and the external stakeholders will help the project define important goals and stay on track in meeting those goals. When the project team is proactive in sharing information, misinformation is less likely to spread. Effective external stakeholder coordination can enhance the project and generate public support.

This tool provides a plan for the project team to obtain stakeholder feedback at designated times during planning and design when feedback would be most beneficial to the team. When stakeholder feedback is not obtained, stakeholders can become disgruntled. Also problematic is when stakeholder feedback is obtained after a design milestone and then the feedback is either ignored or the team loses time and money in revising the design to incorporate the feedback.

Potential benefits include cost savings, schedule acceleration, and owner control of design.



An external stakeholder coordination plan addresses the Alignment Strategy and the Scope Strategy. Stakeholder coordination works to align the project with the stakeholder's needs and the stakeholders with the project goals. Early coordination with stakeholders can help define the scope, and regular communication can help prevent scope creep.

When to Use It?

This tool should be developed at the beginning of the project and can be used from planning through design. This tool is recommended for medium to large project sizes and for moderate complex to complex projects (Table A.5). Smaller or noncomplex projects may benefit if there is a significant external stakeholder contingent to manage.

How to Use It?

At the beginning of a project, the project team identifies key external stakeholders and identifies key milestones when those key stakeholders should be contacted. Contact with stakeholders could include actions such as sending information or holding a meeting. External stakeholder coordination can be included in the project schedule and discussed at project meetings so that the plan is effectively carried out.

Table A.5. Recommended uses for external stakeholder coordination plan.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
4 External Stakeholder Coordination Plan	✓	✓				◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Synthesis of Examples

An external stakeholder is any outside entity with an interest in a project and who can either affect—or by affected by—the project's outcomes. External stakeholders include (but are not limited to) the traveling public, local businesses, local government agencies, regulatory agencies, and advocacy groups. Developing an external stakeholder plan ensures that these outside parties are kept in proper communication with the correct information when information is expected to be available. The proper action can either involve one-way communication (e.g., sending a memo or design submittal) or two-way communication (e.g., a meeting or webinar). Most external stakeholder plans define specific milestones when communication occurs during pre- or post-award phases.

Example

Business 40 (Salem Parkway) Project, North Carolina Department of Transportation (North Carolina DOT)

Although this is a D-B project, it provides a good example of a table to help coordinate stakeholder involvement. This project is in an urban area of Winston–Salem and entails a shutdown of U.S. 421/Business 40. There are many external stakeholders, including commuters, local businesses, hospitals, city officials, and the city beautification nonprofit. The coordination plan divides actions into pre-let and post-let phases. A table identifies project milestones, the coordination action, responsibility, meeting invitees, and goals.

Design–Build External Stakeholder Coordination Plan

The goal of the external stakeholder coordination plan is to systematically engage external stakeholders at the appropriate time in the project delivery process so that their input can be obtained, considered, and incorporated, as appropriate.

(continued on next page)

Phase	Milestone	Action	Unit or Person Responsible	Meeting Attendees	Goal
Pre-Let	1. Start of study letter	Send external scoping table to external stakeholders.	Project manager within Central Project Management Unit	na	Obtain the external stakeholders' input on the external scoping table items they would like to be included in the project. The table can be a living document that is filled in and adjusted as the project and external coordination progresses.
	2. Prior to scoping meeting	Set up meeting with external stakeholders to discuss their external scoping table response and design–build process.	Project manager within Central Project Management Unit	• External stakeholders • Central Project Manager • Division • Design–build • Any other North Carolina DOT staff who may be needed, based upon scoping table information obtained.	Discuss the external scoping table, determine cost-sharing responsibilities, and establish the list of items / betterments to be included in the preliminary design for the project. Educate the external stakeholders on the design–build process and the design–build external stakeholder coordination plan.
	3. Preliminary design complete	Send the preliminary design and external scoping table with quantities and cost estimate for the list of items / betterments included in the project to external stakeholders.	Project manager within Central Project Management Unit	na	Provide the preliminary design and external scoping table that identifies items / betterments, quantities, and cost so that stakeholders can see costs and coordinate internally to refine the list of items / betterments to be included in the project.
	4. 1 to 3 months after sending information noted in No. 3	Set up a follow-up meeting with appropriate external stakeholders to discuss external scoping table items, preliminary design, and design–build process.	Project manager within Central Project Management Unit	• External stakeholders • Central Project Manager • Division • Design–build • Programs Management Office • Any other North Carolina DOT staff who may be needed, based upon scoping table information obtained	Verify the cost share and betterment items agreed to at the scoping meeting are still valid and / or discuss any revisions that may be needed. Leave the meeting with a clear understanding of the items to be included in the municipal agreement and the design–build RFP. Also ensure that the external stakeholders understand the design–build process and the need to meet all upcoming deadlines.
	5. 1 year before design–build let **(Only needed if it has been more than 1 year since the follow-up meeting noted in No. 4)**	Set up a refresh meeting with external stakeholders to discuss external scoping table items, preliminary design, and design–build process.	Design–Build Unit	• External stakeholders • Central Project Manager • Division • Design–build • Programs Management Office • Any other North Carolina DOT staff who may be needed, based upon scoping table information obtained	Verify that the items / betterments agreed to at the follow-up meeting are still valid and / or discuss any revisions that may be needed. Leave with a clear understanding of the items to be included in the municipal agreement and design–build RFP. Also verify that the external stakeholders understand the design–build process and the need to meet all upcoming deadlines.

Phase	Milestone	Action	Unit or Person Responsible	Meeting Attendees	Goal
	6. Technical proposal submittal	Invite external stakeholders to review and comment on design elements and municipal agreement items shown in each team's technical proposal.	Division	• External stakeholders • Division	Obtain external stakeholder comments on design elements and municipal agreement items included in each team's technical proposal. The division will relay this information to the Technical Review Committee during the technical proposal evaluations.
	7. Technical proposal presentation **(optional opportunity)**	Determine if it is beneficial to invite external stakeholders to attend technical proposal presentations.	Design–Build Unit in consultation with the division	• External stakeholders • All other technical proposal presentation attendees	Obtain external stakeholder comments on the technical proposal for each team. External stakeholders will give the Technical Review Committee comments immediately following the last technical presentation.
Post-Let	8. Award of project **(optional opportunity)**	Set up a meeting with external stakeholders to discuss any anticipated post-award design changes to be requested by the division or department.	Division	• External stakeholders • Division	Obtain external stakeholder input on post-award design changes to be requested by the division or department. The division has the final call on what changes, if any, will be made to the design.
	9. Design–build team's preliminary roadway plan submittal	Send a copy of the design–build team's preliminary roadway plan submittal to external stakeholders. Or Invite external stakeholders to review the design–build team's preliminary roadway plan submittal.	Division	• External stakeholders • Division	Provide opportunity for external stakeholders to verify that agreed-upon design elements and municipal agreement items are shown in the design–build team's preliminary roadway plans. Ensure that the stakeholders are aware of the review period duration (usually a maximum of 10 days) and that any comments must be provided to the division before the deadline. The division has the final call on what changes, if any, will be made to the design.
	10. Any other design submittals deemed appropriate based upon coordination above	Send a copy of the design submittal to external stakeholders. Or Invite external stakeholders to review the design submittal.	Division	• External stakeholders • Division	Provide opportunity for external stakeholders to verify that agreed-upon design elements and municipal agreement items are shown in the design submittal. Ensure that the stakeholders are aware of the review period duration (usually a maximum of 10 days) and that any comments must be provided to the division before the deadline. The division has final call on what changes, if any, will be made to the design.

Note: na = not applicable.

5 Regulatory Agency Partnering

This tool improves communication between the project team and regulatory agencies, thus leading to a smoother permitting process.

What Is It?

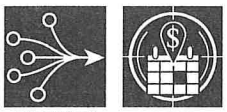
Regulatory agency partnering involves regular meetings and specified channels of communication. This provides a forum for open and honest communication between regulators; the state transportation agency; and the designer, contractor, or design–builder assisting with the permit application. These discussions help explain the ramifications of alternatives to meet permit requirements and to agree on possible solutions at the conceptual level prior to submitting detailed permit applications. The goal is to avoid a cycle of back-and-forth exchanges of permit applications, reviews, and denials.

Why Use It?

The purpose of partnering with regulatory agencies is two-fold. First, it helps regulators understand the impacts of construction, rather than leaving it up to the regulators to interpret alone what the impacts will be. This is crucial because contractors can sometimes have a better understanding of the ramifications of various construction options than the regulators reviewing the permit applications. Likewise, regulators may have a perspective on environmental or other issues that the contractor needs to hear firsthand. Often, there is no perfect solution to meeting regulations. The goal of partnering is to get the project team and the regulators working together toward a common goal of determining a solution with the least negative impact that upholds the spirit of the applicable regulations. Second, by encouraging a dialogue between regulators and contractors, streamlining the permitting process itself can save time in the project schedule.

Partnering and the associated dialogue establishes a working relationship between contractors—who develop construction means and methods—and the regulators, who evaluate those means and methods for permit compliance. By explaining the process and allowing contractors to address the concerns and questions of regulators, the back-and-forth submission of permit proposals and permit denials can be avoided. Permits can be obtained faster, and regulators can be assured that the best measures possible are being taken to satisfy their regulations.

Potential benefits include cost savings; schedule acceleration; ability to fast-track; construction input in design to encourage constructability, innovation, and risk mitigation; and facilitating resolution of third-party issues.



Regulatory agency partnering addresses the Alignment Strategy and the Preconstruction Services Quality Strategy. Meetings with regulatory agencies help build the team alignment project goals with the required regulations. The preconstruction services the CM provides engage them actively with the project team and the regulatory agencies.

When to Use It?

Partnering is most appropriate on projects involving contractors with a demonstrated commitment to fulfilling project goals, contract obligations, and providing high-quality solutions with the lowest cost alternatives. Partnering requires that the contractor have intimate knowledge of the design and is engaged in the permitting process.

This tool is generally recommended for mid- to large-sized projects that are moderately complex to complex (Table A.6).

Table A.6. Recommended uses for regulatory agency partnering.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
5 Regulatory Agency Partnering	✓	✓	✓			○	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

Agencies should first evaluate the contractor's ability and willingness to work directly with regulators to develop the optimal—though not necessarily the lowest cost—permitting solutions. Then, the agency schedules and hosts meetings for all three parties. Initial meetings introduce the regulators to the scope and goals of the project, followed by sharing construction alternatives. Regulators are provided with an opportunity to present their concerns about the construction plans. The contractor can respond to the regulator's concerns and questions and work with the regulator to develop an acceptable solution for permitting. The permit application still needs to be prepared in a complete manner. But the background knowledge gained by the regulator and the early input received from the regulator helps the review process proceed more smoothly.

Synthesis of Examples

A regulatory agency partnership can be designed to simply inform the agency on a specific aspect of a project or to seek input on any issue related to project development. Partnering with a regulatory agency is not meant to bypass any regulations. Successful partnering with regulatory agencies typically

- Engages the regulatory agency early in the project development process,
- Discusses construction options and their associated impacts,
- Clarifies critical regulatory issues that are important to the project and the agency, and
- Leads to the preparation of a permit application that the regulatory agency is, in principle, willing to approve.

Partnering is intended to make the approval process more efficient, which will benefit the regulatory approval process.

Example

Willamette River Bridge project, Oregon Department of Transportation (Oregon DOT)

Oregon DOT and its CM-GC used this tool on the Willamette River Bridge project in Eugene. The CM-GC participated in the early phases of design and was actively

(continued on next page)

involved in applying for project permits. Based on the CM-GC's extensive history of in-water work, the CM-GC helped fine-tune the design of their work platform to minimize its effect on the river and the environment. This required some increase in cost to achieve. Together, Oregon DOT and the CM-GC walked environmental regulators through their design, explained why it was an optimal solution, and explained why alternatives proposed by the regulators would trade reductions in certain impacts for increases in others. This approach resulted in an agreed-upon solution that might otherwise have been rejected in a standard permit application. The overall permitting process time was reduced, and excellent working relationships developed between Oregon DOT, the CM-GC, and the environmental regulatory agencies (Molenaar et al. 2015).

References

FHWA. *Planning and Environmental Linkages Partnering Agreement*. U.S. Department of Transportation, 2009. http://environment.fhwa.dot.gov/integ/final_signed_partnering_agreement_June09.pdf.

Ford, M. L. *NCHRP Web Document 39: Managing Change in State Departments of Transportation: Scan 7 of 8: Innovations in Public–Public Partnering and Relationship Building in State DOTs*. Transportation Research Board, Washington, D.C., 2001. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w39-7.pdf. Accessed April 13, 2018.

Molenaar, K. R., D. D. Gransberg, and D. N. Sillars. *NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction*. Transportation Research Board of the National Academies, Washington, D.C., 2015. https://dx.doi.org/10.17226/22128.

Nevada Department of Transportation. Nevada Department of Transportation Partnering Program. n.d. https://www.nevadadot.com/doing-business/about-ndot/ndot-divisions/operations/construction/partnering-program. Accessed April 14, 2018.

6 Co-Location of Key Personnel

This tool involves all key personnel being located at the same facility during specific phases of the project—particularly, early phases—or for the duration of the project.

What Is It?

Co-location of key personnel requires important project team members to be located at the same facility during agreed-upon phases of a project. This tool brings project resources together in one location, creating the opportunity for increased communication, improved project quality, greater efficiency, and enhanced project understanding.

Why Use It?

When project team members are located in the same facility, availability and communication of the project team members is improved. This arrangement allows a better understanding of expectations between parties and expedites problem solving and conflict-resolution processes, when needed. When using this tool, work is completed more efficiently and with fewer communication-related delays. When co-location does not occur, parties are often disconnected, which causes confusion and miscommunication that can lead to delays. While telecommunication can enhance communication among project team members, in-person communication and team building cannot be replicated by technology. For example, with co-location, impromptu hallway conversations can make positive impacts that regularly scheduled teleconferences cannot replicate.

Potential benefits include actively engaging the contractor in the design phase to encourage constructability, innovation, and risk-mitigation feedback. Co-location can also lead to schedule acceleration and the ability to fast-track because frequent communication with key team members allows for quicker decision making.

Co-location promotes the Alignment Strategy and the Preconstruction Services Quality Strategy by bringing the team together to work in one location and encouraging frequent interaction during design.

When to Use It?

Co-location is a useful tool for any project that requires a high level of collaboration between project team members. This tool can be used throughout the duration of the project, but especially during design. Because of the expense and time commitment associated with co-location, it is recommended primarily for large, long-duration, complex projects (Table A.7). Though co-location is ideal over the life of the project, using it during single phases of the project can be beneficial. In preconstruction, co-location can aid in constructability and innovation. During construction, it can benefit decision making and conflict resolution.

How to Use It?

Co-location involves some or all of the project team working in the same facility. This requirement would be specified by the agency in the RFP. The team can be located at the agency's facility or in a temporary facility at or near the project site.

Table A.7. Recommended uses for co-location of key personnel.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
6 Co-Location of Key Personnel	✓	✓	✓			○	◗	●	○	◗	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Synthesis of Examples

When setting up expectations for co-location in the contract, an agency should consider

- The location, which could be the agency's office, the project location, within a certain radius of the project, or in a designated region or metropolitan area;
- The minimum number of key personnel expected to be co-located;
- The phases when co-location is required, such as design or design and construction; and
- The personnel responsible for providing, furnishing, and maintaining the space.

Example 1

Trunk Highway (TH) 53 Relocation Project, Minnesota Department of Transportation

Minnesota DOT used the co-location tool throughout this project and found it was useful in enhancing the communication between parties. Their project independent cost estimator was not co-located. However, the independent cost estimator called into weekly meetings and attended in person once a month. Minnesota DOT defined co-location in the following RFP and required co-location on their project.

Co-Location

During design, key individuals of the Project Team will be co-located at a facility in the Twin Cities metro area. The CM-GC Contractor, at a minimum, will be required to have their Project Manager co-located with the Project Team. Payment for the Project Manager during the preconstruction services phase of the project shall be made in accordance with the terms of the professional/technical services contract.

Example 2

Walk Bridge Project, Connecticut Department of Transportation (Connecticut DOT)

Connecticut DOT prepared a manual that explains their agency's process for procuring and administering a CM-GC project for the Walk Bridge. It is a guidance manual; not a contract. Co-location is included below as a requirement.

Co-location—Under the terms of the CM/GC contract, the Contractor shall be co-located with key staff from the Design Consultant and the PM Consultant at a location to be determined in Connecticut.

References

Connecticut Department of Transportation. Construction Manager/General Contractor Procurement Guidance Document for the Walk Bridge Project. 2014. http://www.ct.gov/dot/lib/dot/documents/aec/ConnDOT_CMGC_Procurement_Guidance_Document.pdf. Accessed July 23, 2018.

7 Construction Manager–General Contractor Management Fee Table

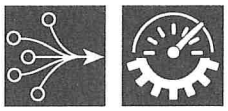
This table lists the costs that are excluded and that are included from the CM-GC management fee.

What Is It?

The CM-GC management fee table has two columns: one for costs excluded from the CM-GC management fee and one for costs included in the CM-GC management fee. Costs can be attributed to tasks (e.g., mobilization), positions (e.g., project manager or project principal), and expenses (e.g., permit fees or rental equipment). This table serves as a reference for the CM-GC when they are preparing their fee proposal during procurement and later when they are preparing invoices throughout the project. It is also a reference for agencies when they review the fee proposal and invoices.

Why Use It?

This tool helps the CM-GC and owner have a common understanding of what can be included in the CM-GC management fee. It helps avoid disagreements between the CM-GC and the owner about what the CM-GC can include in an invoice. Potential benefits include transparency and trust among project stakeholders, which can be beneficial in case there are disagreements down the road.



A CM-GC management fee table helps address the Alignment Strategy and the Construction Efficiency Strategy. It helps establish clear expectations around costs included and excluded in the CM-GC fee. Consequently, construction can later proceed smoothly and efficiently because of the reduced inquiries about invoices and what can and cannot be included. It is important to publish this table early in the project to ensure that it is understood and agreed on by all project parties.

When to Use It?

A CM-GC management fee table is recommended for moderately complex and complex projects that are larger than $10 million (Table A.8). For smaller projects that are not complex, this tool should be considered on a case-by-case basis, depending on whether the likely benefits will justify the added effort.

Table A.8. Recommended uses for the construction manager–general contractor management fee table.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
7 Construction Manager–General Contractor Management Fee Table	✓	✓	✓	✓	✓	◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

The table can be included in the owner's CM-GC manual and/or in the RFP to communicate to all potential CM-GC proposers what items are allowed in the CM-GC management fee. The CM-GC uses this information when preparing the CM-GC proposal and project invoices. The agency uses this information to review the CM-GC proposal and invoices.

Example

I-70 Vail Underpass Project, Colorado Department of Transportation

This project used the CM-GC management fee table provided in Appendix C: Construction General Conditions of the Colorado DOT *CM-GC Manual* to clarify which costs can and cannot be included in the CM-GC management fee. This delineation helped establish a common understanding between the agency and the CM-GC firm.

	Costs NOT TO BE included in CM/GC Management Fee Percentage	Costs TO BE included in CM/GC Management Fee Percentage
Item	Costs for the categories below will be negotiated and included in the direct "Cost of the Work"	Other indirect and non-reimbursable costs to be included in the CM/GC fee percentage are listed below
E.1	Mobilization	Project Principal – all costs
E.2	Project Manager	Project Manager relocation, housing, and subsistence costs.
E.3	Construction Manager/Superintendent	Construction Manager/Superintendent relocation, housing, and subsistence costs.
E.4	All other on-site, construction management staff as approved by the Agency	Additional CM/GC staff relocation, housing, and subsistence cost.
E.5	On-site administrative staff ,including clerical and secretarial staff	Home, branch and regional office administrative support staff and all related costs
E.6	All project direct costs related to Safety	Home, branch and regional office safety support staff and all related costs
E.7	All project direct costs related to Quality Control	Home, branch and regional office quality control support staff and all related costs
E.8	Project office costs for cleaning, set-up/demob, maintenance, security, utilities, rent/lease, equipment, and furniture	Profit
E.9	Materials and equipment handling, including shipping/transport to site and storage costs	
E.10	Costs to co-locate with Agency staff	
E.11	Job site temporary toilet facilities and maintenance	
E.12	Partnering workshops	
E.13	Construction rental equipment	
E.14	Actual cost of permits	
E.15	All project direct costs related to implementation of Agency-approved sustainable practices	
E.16	All project direct costs related to implementation of Agency-approved DBE/ESB program	

(continued on next page)

	Costs NOT TO BE included in CM/GC Management Fee Percentage	Costs TO BE included in CM/GC Management Fee Percentage
Item	**Costs for the categories below will be negotiated and included in the direct "Cost of the Work"**	**Other indirect and non-reimbursable costs to be included in the CM/GC fee percentage are listed below**
E.17	Construction equipment and vehicles at Proposer's internal cost rate, including costs of maintenance and fuel	
E.18	All costs related to cell phones, radios, fax machines, pagers, computers and software.	
E19	All costs of capital and interest; licenses and taxes required by law.	
E.20	Miscellaneous project office costs, including but not limited to, drinking water, printing, reproduction, postage, delivery, and supplies	

References

Colorado Department of Transportation. *Construction Manager/General Contractor (CM/GC) Manual* (Appendix). 2015a. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

8 Construction Manager–General Contractor–Specific Partnering

This tool allows team members and other stakeholders to collaborate to form alignment on CM-GC project goals, issues, roles, and processes to enhance the delivery of the project.

What Is It?

CM-GC–specific partnering usually starts with an initial meeting that brings team members and stakeholders together to begin collaborative discussions about project goals, issues, roles, and processes. Standard partnering tools—such as a roles matrix, an issue-resolution ladder, a project charter, a champion, and partnering evaluations—can be adapted for CM-GC–specific use.

Why Use It?

CM-GC–specific partnering helps establish a framework for team alignment, communication, and collaboration. Collaborative relationships are based on trust, and trust is based on clear, honest communication. CM-GC–specific partnering helps team members know how to function on the CM-GC project. The partnering and goal-setting sessions clarify any disconnects or discrepancies in what is to be achieved on the project. The sessions also introduce efficiencies.

CM-GC–specific partnering helps communicate and remind project team members of the unique aspects of the roles, responsibilities, and processes in a CM-GC project. For example, the agency's functional reviewers may need to be introduced to the accelerated review times stipulated in the contract. The agency's field inspectors also may need to be introduced to the differences between the roles of quality verification and QA. Contractors may need to review their role in having QA performed in addition to QC. In a CM-GC project, the contractor may need to be reminded that a constructability review during design precludes value engineering during construction. The communication and collaboration that flows from partnering can help a team deal with these differences in a way that enhances project performance.

Potential benefits include cost savings, schedule acceleration, construction input in design to encourage constructability, innovation, risk mitigation, and flexibility during design and construction.

CM-GC–specific partnering addresses strategies related to alignment, scope, and preconstruction services quality. Partnering brings project team members together to discuss and clarify goals and responsibilities and helps build productive relationships.

When to Use It?

Specific partnering is useful in instances where the agency transfers quality responsibilities to the contractor. To create a high level of trust, team partnering exercises establish a foundation for the working relationships between the parties.

CM-GC–specific partnering should be developed by the agency prior to selecting a contractor. Then, once the contractor is selected, the agency and contractor need to establish team partnering and goal-setting procedures before construction begins. This step is helpful to avoid any issues that could arise during construction that were not addressed in previous

phases. Partnering meetings and partnering assessments can be used throughout design and construction.

This tool is most beneficial on projects of medium to large size and moderate to complex complexity (Table A.9). Small, noncomplex projects could benefit if there is existing friction among team members before the project begins.

How to Use It?

Partnering is best begun early in the project development cycle. This tool is most effective when the agency develops the CM-GC–specific partnering process before the contractor is selected. This allows the agency to require partnering as part of the RFP or contract. To fulfill the contract, the selected contractor must fully participate in the CM-GC–specific partnering program that the agency establishes. An initial partnering meeting may be a standalone meeting, or it may be paired with the project kickoff meeting. Larger and more complex projects may use an outside partnering facilitator familiar with the distinct aspects of CM-GC. Subsequent partnering meetings and partnering evaluations can be reviewed by the project team and used to improve the project delivery.

Synthesis of Examples

Partnering for CM-GC projects are typically initiated with a meeting or workshop at the beginning of a project or at the beginning of significant project phases (e.g., design or construction). Participants should consist of all project stakeholders, including leadership from the state transportation agency and the contractor. The initial partnering engagement should address the following aspects of the project:

- Project mission,
- Project staffing,
- Expectations of the state and contractor staff,
- Issue resolution,
- Schedule of the follow-up partnering engagements, and
- Other key issues.

One outcome of the initial partnering meeting should be a project team plan that summarizes the above items so that it can be referred to when needed during the course of the project.

Table A.9. Recommended uses for construction manager–general contractor–specific partnering.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
8 Construction Manager–General Contractor–Specific Partnering	✓	✓	✓	✓	✓	◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Example

South Fork Smith River Road, FHWA

This project replaced of the George E. Tryon Bridge, located in Del Norte County along County Road 427 [Forest Highway 112 (FH 112)], also known as South Fork Smith River Road in northwestern California. The overall project length is approximately 0.2 miles and includes the bridge and the approaches. Traffic must be maintained on the routes throughout construction. The existing bridge was removed as part of the project. In the request for proposal, FHWA emphasized the need for partnering, as stated in the following excerpt:

> The intent is to form a partnership with Central Federal Lands Highway Division (CFLHD) [the Engineer(s)], Del Norte County (the Owner), sub-contractors, and you as the Construction Manager/General Contractor. The focus is on a partnership in which we minimize risk, expedite and improve construction schedule, maximize innovation and constructability, significantly reduce costs, [and] enhance quality, while also working within funding limitations. An important role of the CM is to help acquire the information to significantly reduce risk. We anticipate that your CM involvement will help provide valuable cost, schedule, and constructability input during the early phase of design to improve constructability and deliver a quality project significantly under budget and ahead of schedule.

References

AASHTO. *AASHTO Partnering Handbook,* 2nd edition (draft). Washington, D.C., 2017.

Arizona Department of Transportation. *Design-Build Procurement and Administration Guide,* 3rd Edition. 2007. https://azdot.gov/docs/default-source/construction-group/designbuildguide.pdf?sfvrsn=0. Accessed February 10, 2018.

International Partnering Institute. *Collaborative Partnering Best Practices Guide.* Livermore, CA, 2017.

9 Continuity of Team Members

The contractor and key team members from the agency must remain involved throughout the design and construction phases to enhance project understanding, consistency, and communication.

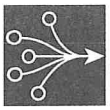
What Is It?

CM-GC projects can take advantage of collaboration to seek efficient and innovative design and construction solutions. Collaboration is enhanced when trust exists, and trust is built through ongoing relationships. By keeping key team members involved during design and construction, project knowledge and communication channels are leveraged for efficient project management.

Why Use It?

Continuity of team members can help a team avoid misunderstandings and mistakes because key team members have a strong knowledge of the project background, decisions, and the intent behind those decisions. Continuity of team members creates ownership and understanding of design intent. Replacing a key member of the team during construction can lead to situations where past design decisions are rediscussed because of a lack of knowledge of the project. Additionally, if unexpected conditions occur in the field, the response to those decisions may not be consistent with the project's intent. This can happen when new team members have not been fully immersed in the project from the design phase.

Potential benefits include schedule acceleration and construction input in design to encourage constructability, innovation, and risk mitigation.



Continuity of team members addresses the Alignment Strategy and Preconstruction Services Quality Strategy. Key team members develop relationships throughout the life of the project, which fosters alignment. The quality of preconstruction services is enhanced when team member involvement is consistent.

When to Use It?

The continuity of key team members should begin in planning and through project closeout. The larger and more complex a project is, the more potential benefit there is from fostering continuity in the team members (Table A.10).

How to Use It?

Assign team members in planning and design who will continue their involvement with the project through construction and closeout. This is true of CM-GC and design staff, as well as of agency staff. Although many agencies include statements about retaining key personnel, these requirements can sometimes be difficult to enforce. There are times when team members cannot be assigned to a project, such as when a project is delayed and personnel are reassigned to other projects. During a project, a team member might be promoted, become ill, resign, or retire. In these situations, assigning new team members is unavoidable. Every effort should be made to assign personnel with appropriate qualifications and to provide briefings for new personnel so that they understand and are knowledgeable about the project's background. Bringing new lead construction personnel on during construction puts them at a disadvantage because they

Table A.10. Recommended uses for continuity of team members.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
9 Continuity of Team Members	✓	✓	✓	✓	✓	◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

do not have history with the project, and they lack an understanding of how risks have been assigned and mitigated. Without this background knowledge, they may default to treating risk like they would for a D-B-B project instead of the way the CM-GC team has agreed to approach the risk. An agency should think through the ramifications of assigning an agency staff member primarily to a designated project in order to provide team continuity. This can take an agency staff member away from other assignments and commitments that will need to be covered by others.

Synthesis of Examples

An agency should first consider which team members it will be dedicating to a project. The time commitment should be estimated and other responsibilities should be adjusted to allow the team members to fulfill their roles throughout the entire project. If an agency expects the contractor to maintain continuity of team members, then this expectation should be clearly communicated in the contract. The roles in which continuity is expected should be identified, and the process to replace these people should be explained. The project team should plan for onboarding new team members during the project, whether they are subcontractors or replacements of key personnel. Onboarding should provide an overview of project scope, goals, decisions, roles and responsibilities, and project issues and challenges.

Example

Trunk Highway (TH) 53 Relocation Project, Minnesota Department of Transportation

This CM-GC project benefited from having the contractor and key personnel from the agency involved throughout the project. The RFP included the following statement:

> **Change in Proposer's Organization**
>
> It is expected that the Key Personnel presented in the Proposal will be available for the duration of the Project. After submittal of the Proposal, if a Proposer

(continued on next page)

> wishes to change its organization form that [is] described in its Proposal, Proposer shall obtain written approval of the change from the Commissioner or designee. This includes any changes in the form of organization of any CM/GC firm or individual identified in the Proposal (including additions, deletions, and reorganization). Modifications to the Proposer's Team or Key Personnel listed in the Proposal will not be approved without justification. Examples of possible justification include death of a team member, change in employment status, bankruptcy, inability to perform, organizational conflict of interest, or other significant cause. To qualify for the Commissioner's approval, the written request shall document that the proposed removed, replaced, or added CM/GC firm or individual identified in the Proposal. The Commissioner will use the criteria specified in the RFP to evaluate all requests. Any such request shall be addressed to the Project Director at the address set forth in another section. The Commissioner is under no obligation to approve such requests and may approve or disapprove a portion of the entire request at his or her sole discretion.

10 FHWA Involvement Overview

This tool is a table or list that briefly describes the way a project interfaces with FHWA on a federally funded project. This interface is often determined based on FHWA local division interest defined in stewardship and oversight agreements.

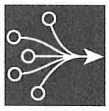
What Is It?

FHWA must be involved on federally funded projects. This level of involvement may vary by project determination. Sometimes project teams have a difficult time keeping track of when to interface with FHWA. This tool provides a succinct overview of FHWA involvement on federally funded projects. It also summarizes FHWA involvement in a federally funded project based on FHWA's final rule and agency agreements with FHWA. FHWA involvement overview lists the project activities in which FHWA is involved and specifies the role or action needed, such as consult, invite, authorize, review, approve, or concur.

Why Use It?

A description of FHWA involvement provides an overview of all the processes and procedures in which FHWA must be included. This includes project selection, administration, procurement, preconstruction, and price proposal. A summary of FHWA involvement helps the agency fulfill federal requirements by involving FHWA in processes and procedures when required. Without this summary, the level of FHWA involvement and required actions can become a source of confusion. Delays may result because of revisiting decisions when FHWA involvement has been overlooked. In some cases, delays may cause rework.

Potential benefits include schedule acceleration and owner control of design. Involving FHWA at the right time helps avoid delays caused by revisiting decisions when FHWA has been accidentally bypassed. Keeping track of FHWA requirements helps the agency and the federal government stay in control of design and keep momentum with decision making.


ALIGNMENT


SCOPE

FHWA involvement overview addresses the Alignment Strategy and the Scope Strategy. This tool clearly explains the expectations of FHWA involvement and reinforces the scope of that involvement and the responsibilities the project team has to keep FHWA involved.

When to Use It?

A description of FHWA involvement should be developed at the initial project development phase and is referenced throughout the project. This tool is recommended for projects of all sizes and complexity, whenever FHWA is involved in a project (Table A.11).

How to Use It?

A description of FHWA involvement is used by the project team to appropriately inform, consult, and invite FHWA, as required, to attend meetings and review documents. When considering a project for federal funding, the agency should contact its local FHWA division to determine whether the project is a project of division interest. This status will determine the level of FHWA project involvement according to the agency's FHWA stewardship and oversight agreement.

Synthesis of Examples

It is critical for an agency to work closely with FHWA on a federally funded project. The first step is to determine whether the project is a project of division interest. One or a few team

Table A.11. Recommended uses for FHWA involvement overview.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
10 FHWA Involvement Overview	✓	✓	✓	✓	✓	●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

members may be responsible for coordinating with FHWA, but all team members should be made aware of the project elements that FHWA needs to have input on. Time should be allotted in the project schedule for this coordination.

Example 1

Trunk Highway (TH) 53 Relocation Project, *Minnesota Department of Transportation CM-GC Manual* (draft)

During this federally funded CM-GC project, Minnesota DOT regularly involved FHWA in project activities and shared project documents. Since this project, Minnesota DOT has developed the following table:

Overview of FHWA involvement on construction manager–general contractor projects.

MANUAL SECTION	WORK ACTIVITY	PROJECTS OF DIVISION INTEREST (PODI)		NON-PODI	
		MnDOT Action	FHWA Action	MnDOT Action	FHWA Action
PROJECT SELECTION AND INITIAL PROJECT DEVELOPMENT—SECTION 2					
2.2.3	Project Goal Setting	Consult	Consult	Consult	Consult
2.3	Project Delivery Selection	Invite	None	Invite	None
ADMINISTRATION—SECTION 3					
3.4	Potential Conflict of Interest	Notify	None	Notify	None
PROCURING THE CM-GC CONTRACTOR—SECTION 4					
4.3	Notify Legislature—Intent to Use CM-GC	Copy	None	Copy	None
4.9	At-Risk Final Design	Notify	None	Notify	None
4.12	Contract Payment Provisions	Consult	Consult	Consult	Consult

MANUAL SECTION	WORK ACTIVITY	PROJECTS OF DIVISION INTEREST (PODI)		NON-PODI	
		MnDOT Action	FHWA Action	MnDOT Action	FHWA Action
4.14.2	Request for Qualifications–Request for Proposals Development Meetings	Invite	None	Invite	None
4.14.3	Request for Preconstruction Services	Prepare	Authorize[5] (3 Days)	Prepare	Authorize[5]
4.14.3	RFQ	Prepare	Review[1] (14 Days)	Prepare	None
4.14.3	RFP	Prepare[3]	Approve (14 Days)	Prepare	None
4.14.4	RFQ-RFP Clarifications	Prepare[2]	None	Prepare	None
4.14.5	RFQ-RFP Addenda	Prepare	Review[1] (3 Days)	Prepare	None
4.15	Reissuing Procurement	Consult	Consult	Consult	Consult
4.15	Cancelling Procurement	Notify	None	Notify	None
4.16	Statement of Qualifications Proposal	Invite	None	Invite	None
4.16	Short List	Prepare[2]	None	Prepare	None
4.16.3	Request for Concurrence in Award	Prepare	Concur in Award	Prepare	None
4.18	Debriefing	Invite	None	Invite	None
PRECONSTRUCTION ACTIVITIES—SECTION 5					
5.2.2	Partnering	Invite	None	Invite	None
5.2.6	Focus of Value Engineering Workshop	Consult	Consult	Consult	Consult
5.5	30%–60%–90% Plans	Prepare	None	Prepare[2]	None
5.5	Design Review–Risk Workshop	Invite	None	Invite	None
5.5	Price Variance Report	Prepare[2]	None	Prepare[2]	None
5.5	Price Reconciliation Meeting	Invite	None	Invite	None
PRICE PROPOSAL PROCESS—SECTION 6					
6	Issue for Price Proposal	Prepare[6]	Approve (14 Days)	Prepare	None
6	IFPP Addenda	Prepare	Review[1] (3 Days)	Prepare	None
6	Request for Authorization	Prepare[4]	Authorize (7 Days)	Prepare[4]	Authorize (7 Days)
6	Request for Concurrence in Award	Prepare	Concur in Award (3 Days)	Prepare	None
6	Price Proposal Abstract	Prepare	Review	Prepare	None
6	Reject Price Proposal	Prepare	Concur	Prepare	None
6	Terminate CM-GC Contract	Notify	None	Notify	None
6	Use Another Procurement Process	Prepare	Approve	Prepare	Approve

Example 2

Colorado Department of Transportation *CM-GC Manual*

The Colorado DOT *CM-GC Manual* includes the following description of FHWA oversight and requirements on federally funded projects:

> **4.5 FHWA Oversight and Requirements**
>
> FHWA may provide project oversight if the CM/GC project includes federal funding. FHWA's level of involvement will depend on if FHWA determines the project to be a Project of Division Interest (PoDI) - project identified by the Division Office as having an elevated level of risk (threat or opportunity) and, therefore, warrants an increased level of Federal Oversight to ensure the successful project and/or Federal Highway Program delivery. If the project is determined to be a PoDI, [Colorado] DOT must meet with the FHWA Operations Engineer assigned to the project to determine what project elements FHWA will be involved in. The FHWA Operation[s] Engineer, along with [the] team leader, will then create a [project-specific] stewardship agreement that will detail FHWA's participation.
>
> If the CM/CG project is determined to be a PoDI, FHWA [. . .]:
>
> - [. . .] may participate in [. . .] evaluating the 13 criteria concerning the applicability of CM/GC
> - [. . .] may review project level Request for Proposals (RFP) procedures (specific attention to goals and selection criteria)
> - [. . .] will approve Fiscal Management Information System (FMIS) action for the General Contractor (this is the CM/GC Preconstruction Phase services authorization and is separate from the Design Consultant)
> - [. . .] may review 30% plans
> - [. . .] may review 90% plans
> - [. . .] may participate in the Construction Agreed Price (CAP) meeting(s)
> - All normal FHWA oversight approvals (design variances, proprietary items, etc.)
> - [. . .] will approve FMIS for the Construction Phase. Approval occurs prior to CAP Proposal.
>
>   Required:
>   - Environmental clearance
>   - Right of Way Certification Letter
>   - Utility Certification Letter
>   - 100% plans or approved CAP package plans and specifications[,] which may be less than 100%
>   - Value Engineering Study (if required)
>   - Independent Cost Estimator (ICE) estimate from most recent Opinion of Probable Construction Costs (OPCC) Submittal
>   - Contractor estimate from most recent OPCC Submittal
>   - FHWA may concur in Award for construction
>   - FHWA may perform periodic construction inspections
>   - FHWA may perform a Final inspection and project acceptance

If the project is not a PoDI, FHWA must still:

- Approve FMIS action for General Contractor (this is the CM/GC Preconstruction Phase services authorization and is separate from the consultant designer)
  - Approve FMIS construction phase. Approval occurs prior to CAP Proposal.

Required:

- Environmental clearance
- [Colorado] DOT Form 1180
- [Colorado] DOT Form 463
- Value Engineering Study (if required)
- ICE Estimate from most recent OPCC Submittal

References

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC)*. 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

FHWA. *Construction Manager/General Contracting Final Rule.* 2016. https://www.federalregister.gov/documents/2016/12/02/2016-28977/construction-managergeneral-contractor-contracting. Accessed August 20, 2017.

FHWA. *Federal-Aid Program Administration*. 2018. https://www.fhwa.dot.gov/federalaid/stewardship/. Accessed August 20, 2018.

FHWA Minnesota Division and Minnesota Department of Transportation. *Stewardship & Oversight Agreement on Project Assumption and Program Oversight by and Between Federal Highway Administration, Minnesota Division and the State of Minnesota Department of Transportation.* 2015. https://www.fhwa.dot.gov/federalaid/stewardship/agreements/mn.pdf.

11 Permit Commitment Database

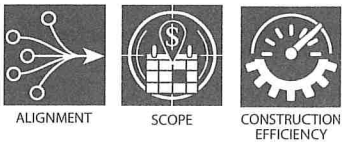
This database is a summary of all commitments included in the permits and agreements, which helps the project team keep track of all commitments.

What Is It?

Every project requires some kind of permit. Projects that cross multiple jurisdictions may require many permits. Permit requirements may cover a number of issues that can be difficult for project teams to keep track of. This database serves as a handy reference that summarizes key information about all the permit commitments on a project.

Why Use It?

A permit commitment database keeps the project team focused on meeting all permit requirements. This tool guards against overlooking a permit commitment made on the project. Potential benefits include cost and schedule savings, as well as resolving third-party issues that can affect cost and schedule. Identifying the permits and their responsible parties early on may also allow for additional input on the design.



A permit commitment database helps address all of the Alignment, Scope, and Construction Efficiency strategies. It helps establish clear permitting goals and responsibilities for the agency and the CM-GC team members. The database allows project stakeholders to begin communicating about permits during the early stages of the project and establishing clear expectations so that the construction phase can later proceed smoothly.

When to Use It?

The permit commitment database can be included with the RFP and can state whether the owner has already obtained specific permits. This can help a contractor during the proposal stage better understand and plan for all permit commitments from the beginning. Permit commitments must be met throughout the duration of the project. If the CM-GC firm is obtaining permits, then the agency can request that the CM-GC create the permit commitment database.

A permit commitment database is recommended for projects of all sizes, especially moderately complex-to-complex projects (Table A.12). For projects that are not complex, the project team can consider using this tool on a case-by-case basis.

How to Use It?

The permit commitments database is prepared by whoever is responsible for obtaining the majority of the permits—either the agency or the contractor. The permit commitment database can be used as a checklist to make sure all commitments are made and maintained. The database provides information such as the name of the jurisdiction issuing the permit, the permit number, a description of the topic, who is responsible, and where to locate the requirements within the permit.

Table A.12. Recommended uses for permit commitment database.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
11 Permit Commitment Database	✓	✓	✓	✓	✓	◗	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Table A.13. Summary of conditions from required permits.

Permit Number	Unique ID No.	Topic	Requirement	Responsibility	Source Reference Heading	Source Reference Page	Status	Check-In Date
	1							
	2							
	. . .							

Note: . . . = continuation of Unique ID No.

Synthesis of Examples

Good practice for this tool follow the points identified below:

- The RFP summarizes the required permits, possibly as part of an appendix.
- Conditions from each of the required permits are identified and summarized in a table that serves as a database throughout the project (Table A.13).
- The table has columns for the permit number, permit ID, topic, requirements, responsibility, source reference details, and page numbers for ease of navigation.
- A status column can be added to indicate when requirements are fulfilled or on track to being fulfilled.
- The database is searchable based on requirements, topic, a certain party's responsibility, permit status, and so on.

Example

I-405, NE 6th Street to I-5 (Bellevue to Lynnwood) Widening and Express Toll Lanes Project, Washington State Department of Transportation (Washington State DOT)

Although this is a D-B project, the permit commitment table provides a template that could be applied to CM-GC. This project crossed a number of jurisdictions and required permits from multiple agencies. The RFP summarized these permits in an appendix. Conditions from each of these permits were identified and summarized in the following table that served as a database throughout the project. The table has a column for the permit, topic, requirements, responsibility, and source reference details. This database can be searched for all requirements from one type of permit. Alternatively, it can be searched for all requirements that are the responsibility of a certain party. A status column could be added to indicate when requirements are fulfilled or on track to being fulfilled.

I-405, NE 6th to I-5 Widening and Express Toll Lanes Project commitments list.

Permit Number	Unique ID No.	Topic	Requirement	Responsibility	Source Reference Details	
					Heading	Page
ESA-National Marine Fisheries -1	1	Stormwater Facilities, Stormwater	The Design–Builder shall reconfigure and/or enlarge existing facilities so as to provide flow control to address the estimated 19.2 acres of impervious surface that falls within the basins that are outside the [. . .] Sammamish River Basin, which is exempt from flow control. This target flow control catchment area includes the Project's new impervious surface as well as restoration of any flow control facilities that are in place prior to the project. Flow control will be provided by infiltration ponds, detention ponds, detention vaults, and combined stormwater treatment wetlands/detention ponds according to [Washington State DOT] guidelines. Up to 17 flow control facilities will be needed for the project. Several of these existing facilities are being increased in size to accommodate the current project. See RFP Appendix H1 for a detailed breakdown and additional hydraulic information.	Design–Builder	Treating Stormwater	3
ESA-National Marine Fisheries - 2	2	Stormwater Facilities, Stormwater	The Design–Builder shall provide stormwater runoff treatment for 13.89 acres of new impervious surface and will complete a stormwater retrofit for an additional 4.69 acres of existing impervious surface (out of the approximately 323 acres of existing impervious surface). Stormwater in the area currently discharges to the Sammamish River, North Creek, Juanita Creek, Forbes Creek, Yanow Creek, and local tributaries within the North Bellevue basin. See RFP Appendix H1 for a detailed breakdown and additional hydraulic information.	Design–Builder	Treating Stormwater	2
ESA-National Marine Fisheries-3	3	Work In the Sammamish River	The Design–Builder shall place up to a total of 450 square feet of riprap [to] be installed below the Ordinary High Water Mark (OHWM) for the two new stormwater outfalls to the Sammamish River. The outfalls are above OHWM of the Sammamish River, but the riprap will be placed below the outfall to protect against streambank erosion. In-water work on the Sammamish River will also include installing Large Woody Debris (LWD) and round rock within the river. In addition to the riprap installation, Best Management Practices (BMP) installation will temporarily impact up to a total of 400 square feet. Installation of LWD and round rock will occur within the same 450 square feet as the riprap. Bank stabilization methods will incorporate recommendations from the Integrated Streambank Protection Guidelines.	Design–Builder	Work in the Sammamish River	4

References

Washington State Department of Transportation. I-405/NE 6th Street to I-5 Widening and Express Toll Lane Project, Request for Proposal. July 25, 2011. Appendix A, Z2. http://www.wsdot.wa.gov/biz/contaa/ProjectContracts/DESIGNBUILDCONTRACTS/NE%206TH%20ST%20TO%20I-5/Default.htm. Accessed December 16, 2017.

12 Discipline Task Force

A discipline task force is a group of individuals focused on one specific discipline. Discipline task forces are formed to ensure coordination across project disciplines.

What Is It?

Each discipline task force focuses on a specific discipline of work, such as structures, roadway, drainage, or environmental. Members of a task force include designers, key construction personnel, and the agency's discipline experts. Task forces generally meet weekly to discuss discipline-related design progress and issues and to plan phased action items, as necessary. The minutes from each task force meeting are recorded and distributed.

Why Use It?

This tool ensures that attention is given to every aspect of the project. Furthermore, implementing regular discipline-specific meetings ensures that any necessary action is taken in a timely manner.

The primary purpose of a discipline task force is to provide consistency and improve coordination across all project disciplines. Additionally, regular meetings on specific topics aid in management and communication between all parties, project quality enhancement, and keeping the project on schedule.

Potential benefits include allowing for construction input in design to encourage constructability, innovation, and risk mitigation. This allows for the ability to fast-track through phasing the project, as needed, and to bid out early work packages, if desired.


SCOPE


PRECONSTRUCTION QUALITY

Discipline task forces address the Scope Strategy and the Preconstruction Services Quality Strategy. These task forces establish clear scopes within each project discipline. They also ensure the quality of preconstruction services by allowing for the CM-GC firm's active participation in reviewing designs and verifying competitive pricing for estimates of each individual discipline's designs.

When to Use It?

It is feasible for discipline task forces to hold meetings during any phase of a project, but they are most common during design. Additionally, there is potential for new task forces to form throughout the project as the need arises.

Discipline task forces for complex projects that are higher than $10 million in value are recommended (Table A.14). For smaller projects that are moderately complex, the project team can consider using this tool on a case-by-case basis. Discipline task forces are not recommended for noncomplex projects because the benefits will probably be small and not justify the cost and effort.

How to Use It?

A discipline task force is composed of people representing each necessary party on a project. Task force members must be available to meet regularly to discuss their discipline and responsibilities in relation to the project. These individuals need to have the knowledge and authority to be able to address issues relating to the discipline. Task force members should be involved in

Table A.14. Recommended uses for discipline task force.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	**Design**	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
12 Discipline Task Force		✓				○	◗	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

more than one discipline task force in order to ensure consistent cross-discipline coordination. Each discipline task force should have clear ground rules, scope, and deliverables; otherwise, there is a risk of getting out of alignment with the project goals.

Synthesis of Examples

When an agency wants to be involved in the development and review of a specific discipline that is particularly relevant or unusual on a project, the requirement of a discipline-specific task force can be included in the RFP. When task force meetings are held or communications for the task force are circulated, all task force members need to be engaged in order to keep project progress on that discipline moving forward. If agency personnel assigned to a task force do not attend task force meetings or respond to task force communications, the project will lose the benefit of this tool. Since disciplines may overlap, there may be times when one discipline task force meets with members of another task force.

Example

Trunk Highway (TH) 53 Relocation Project, Minnesota Department of Transportation

This CM-GC project was on a strict deadline to vacate the existing roadway easement for mining operations. Minnesota DOT functional teams met weekly with discipline task forces to enhance the quality and speed of the design.

References

Lane, L. B. *NCHRP Synthesis 373: Multi-Disciplinary Teams in Context-Sensitive Solutions.* Transportation Research Board of the National Academies, Washington, D.C., 2007. https://dx.doi.org/10.17226/23123.

13 Independent Party Design Review

This tool is a design review performed by a third-party consultant that the agency hires.

What Is It?

An independent party design review is a process in which the agency hires a third-party firm to provide quality inspections and verification reviews during design. The independent review team should be qualified consultants who can provide objective design reviews that are not biased by the contractual relationship that exists between the project's designer and the agency. It is one way to provide additional resources for an agency.

Why Use It?

There are instances in which an agency may not have the necessary resources or expertise to provide complete and thorough design reviews, especially when the agency does not perform the design in-house. In these cases, it can be beneficial for the project to hire a third-party independent review consultant to perform design reviews on behalf of the agency. This places the design review responsibilities on the hired independent party, but the agency still controls how the reviews occur.

This tool supplements the resources and time that an agency has to allocate to a project. Because the independent party performs the design reviews, the agency can reduce the staff and time dedicated to reviews. Also, the selected review consultant can be required to possess additional expertise to perform a more in-depth review than a typical agency reviewer could provide. By having a highly qualified independent reviewer perform reviews of complex and specialty projects, the risk related to technical requirements can be reduced.

Potential benefits include maintaining the agency's control of the design, while also reducing agency staff time devoted to reviews. This tool could also lead to cost benefits if technical requirement risks are reduced due to the expert reviews. Finally, this tool can provide schedule benefits in instances when the agency lacks the resources and time needed to meet specific design milestones.

An independent party design review addresses the Scope Strategy. This tool ensures the design meets the project scope and quality defined by the agency. It also helps ensure that the design is up to the agency's standards before the CM-GC firm starts expending effort working with the design to provide preconstruction services, including cost estimation, constructability analyses of the design, and so on.

When to Use It?

Third-party independent reviews are most helpful on specialty projects, when the agency lacks the necessary resources and time to meet specific design milestones, or when the agency lacks the expertise needed to perform a detailed review (Capers et al. 2011).

An independent party design review is recommended for moderately complex and complex projects that are higher than $10 million in value (Table A.15). An independent party design review is not recommended for smaller projects and noncomplex projects because the benefits will probably not justify the cost.

How to Use It?

Before design begins, the agency needs to decide if design reviews can be accomplished internally. This decision is based on the availability and expertise of agency staff. When a third-party

Table A.15. Recommended uses for an independent party design review.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	**Design**	Preconstruction	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
13 Independent Party Design Review		✓				○	●	●	○	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

independent review team is needed, they conduct the reviews based on the process and requirements developed by the agency. This includes reviewing the design for all required quality aspects developed by the agency prior to starting design. In addition, the independent review team will provide reviews at all specified intervals agreed to by the agency and the design team.

Synthesis of Examples

When an agency brings in an independent party design reviewer, it should be sure to include the reviewer in partnering meetings, relevant project meetings, and the appropriate discipline-specific task forces. The agency should clarify with the designer whether document distribution for the review will be the responsibility of the agency or the designer. When the agency receives an independent party design review, it should read and assess the review to make sure that it is in agreement with the independent reviewer's comments and that those comments are consistent with other comments prepared by others in the agency.

Example

SH 82 Grand Avenue Bridge Project, Colorado Department of Transportation

Colorado DOT replaced a traffic bridge and a pedestrian bridge in this large, complex, phased project located in an urban Colorado area. Colorado DOT contracted with consultants to perform independent party design reviews to supplement the work of the agency's staff. Although this project did not have federal funding, Colorado DOT also asked FHWA to perform an independent review to benefit from their expertise.

References

AASHTO. *AASHTO Guide to Quality in Preconstruction Engineering*, Washington, D.C., 2003.

AASHTO. *AASHTO Consultant Contracting Guide*, Washington, D.C., 2008a.

Capers, H., H. Ghara, K. C. Rehm, N. Boyd, T. Swanson, C. Swanwick, R. J. Healy, R. W. Dunne, and R. S. Watral. NCHRP Project 20-68A, Scan 09-01: Best Practices in Quality Control and Assurance in Design. Transportation Research Board, Washington, D.C., 2011. http://onlinepubs.trb.org/onlinepubs/nchrp/docs/nchrp20-68a_07-01.pdf. Accessed April 13, 2018.

FHWA. *Guidance on QC/QA in Bridge Design in Response to NTSB Recommendation (H-08-17)*. U.S. Department of Transportation. 2011. https://www.fhwa.dot.gov/bridge/h0817.pdf. Accessed April 14, 2018.

14 Plan Standards

Plan standards are adapted to the goal of developing plans and specifications for building a project, rather than for bidding a project.

What Is It?

Instead of preparing plans for bidding by multiple contractors who have not participated in the design phase, designers prepare plans to be used by the CM-GC who has participated in the design phase. Thus, when there is a strategic reason, plans can deviate from standard formatting and still communicate the needed information to the contractor without creating ambiguity. The owner still needs a complete set of as-built drawings, so plans should be prepared for the purposes of building the project and for documenting as-built conditions.

Adjustments to plan standards address the Alignment Strategy and Preconstruction Services Quality Strategy. Agreeing on adjusted plan standards helps bring the team into alignment on what the design deliverable will look like, based on what the contractor will need to build the project. Ensuring that the plans contain the information needed by the contractor to build the project requires active participation of the contractor during design, thus promoting preconstruction services quality.

Why Use It?

Implementing CM-GC–specific plan standards can expedite the design phase. This is possible because the contractor is participating in the design phase and has in-depth project background to draw from when interpreting and using the plans. Potential benefits attributed to this flexibility during design plan development are primarily cost savings and schedule acceleration from more streamlined plan development.

When to Use It?

Plan standards development occurs during the design phase. It is recommended for complex projects of medium to large size (Table A.16). It may be used in other projects, but the scale of the project reduces the impact of the benefit for the project team. On smaller projects that will not last a long time, the agency may feel it is easier to stick with the typical plan standards than try to adjust to a revised plan standard for such a short project.

Table A.16. Recommended uses for plan standards.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	**Design**	**Preconstruction**	Construction	Closeout	Noncomplex	Moderately Complex	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
14 Plan Standards		✓	✓			◗	◗	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

As design plans are being developed, the project team discusses the best way to convey information for construction and the requirements for as-built drawings. If the most efficient way deviates from the standard formatting, the project team seeks approval from the agency to deviate. The agency should think ahead to what information they want on the as-built plans. Some details for construction—such as survey data or materials specifications found on summary sheets—may be able to be communicated through tables of data apart from the plans. But if this information is needed by the agency on the as-built plans, then it should be incorporated into the project plans.

A common example of a plan standard deviation relates to removals. If a utility such as a communications cable must be removed through the length of the project, the removal information can be placed on one plan sheet rather than on every plan sheet. Alternatively, roll plots can be used instead of plan sheets. It may be convenient for a contractor to have a roll plot of pavement and utility removals rather than a large number of individual plan sheets. The plan sheets are convenient for bidding, but the roll plot is convenient for construction. Because the work is not being bid, the roll plot is all that is needed. Typically, removals are not needed on as-built drawings, so the agency is not sacrificing any recordkeeping information.

Synthesis of Examples

Adaptation of plan standards should be used to meet function, quality, safety, and any other standards the agency needs to maintain. This tool should not be used as a shortcut around needed standards. The appropriate application is when a general standard does not readily apply to a particular situation. Removals are a good example of this situation. Another example is when an agency's standard details jump over what is needed. For example, if a 4-feet-high reinforced box culvert is needed and the agency only has details for 3 feet and 5 feet, it may be appropriate to use a detail from a different agency for a 4-feet-high box.

Example

Florida Department of Transportation (Florida DOT) *Plans Preparation Manual, Volume 1: Design Criteria and Process*

Florida DOT uses this *Plans Preparation Manual* to describe the design criteria, as well as procedures for contract plans for all roadway and structure projects. The required procedure and how to identify when nonconventional projects deviate from this procedure are described below. Key to the success of this procedure is to clearly communicate to project team members when deviations to standards are occurring.

PROCEDURE

The criteria in this manual represents requirements for the State Highway System [that] must be met for the design of [Florida DOT] projects unless approved Design Exceptions or Design Variations are obtained in accordance with procedures outlined in this manual.

Roadway and structures design is primarily a matter of sound application of acceptable engineering criteria and standards. While the criteria contained in this manual provides a basis for uniform design practice for typical roadway design situations, precise standards [that] would apply to individual situations must rely on good engineering practice and analyses.

Special requirements for Non-Conventional Projects (e.g., Design–Build Projects and all Non-Design–Bid–Build, Public–Private Partnership Projects may be shown in a Modification for Non-Conventional Projects box, as shown in the following example):

Modification for Non-Conventional Projects:
Delete ***PPM*** 7.2.6 and replace with the following: **7.2.6 Signing Project Coordination** The Design–Build firm must submit a master signing plan with the Technical Proposal. The master signing plan can be on a roll plot.

These boxes are located at the beginning of the chapter or after a section, paragraph, or table [that] is to be modified. The requirements listed within these boxes are only applicable to Non-Conventional Projects.

References

Florida Department of Transportation. *Plans Preparation Manual, Volume 1: Design Criteria and Process.* 2017. http://www.fdot.gov/roadway/ppmmanual/2017/Volume1/2017Volume1.pdf. Accessed February 11, 2018.

15 In-Progress Design Workshops

These meetings between the designer, the contractor, and the agency take place throughout the design process to discuss and verify design progress.

What Is It?

Throughout the design phase, the agency, the contractor, and the designer are able to request a meeting to discuss the progress of the design. These in-progress design workshops are intended to assist the designer with resolving design issues and questions.

Why Use It?

In-progress design workshops provide a forum for the relevant project parties to review and discuss design details. This tool establishes communication between project parties at a time when decisions have a large impact on the quality of a project. All parties involved in the project are able to align their understanding of the project and assign responsibility for future actions. Furthermore, the workshops provide an opportunity to enhance the quality of the project and enable the agency to review design information.

Keeping the team members engaged through in-progress design workshops can benefit the project through cost savings and schedule acceleration by keeping the team aligned, getting feedback early, and avoiding design rework. In-progress design workshops provide a forum for contractor input on constructability, innovation, and risk. These workshops also allow the owner to stay informed and in control of the direction of the design.


ALIGNMENT


PRECONSTRUCTION QUALITY

In-progress design workshops address both the Alignment Strategy and the Preconstruction Services Quality Strategy. The communication that occurs in these meeting helps keep the project team aligned on broad project goals, as well as on project details. The multiple perspectives shared by the designer, contractor, and owner at these meetings enhance the preconstruction services quality.

When to Use It?

This tool is implemented at any stage during the design phase of a project (Table A.17). It is best suited to projects delivered using alternative project delivery methods in which the designer and the contractor are contractually obligated to coordinate with one another. This tool is

Table A.17. Recommended uses for in-progress design workshops.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	**Design**	**Preconstruction**	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
15 In-Progress Design Workshops		✓	✓			◗	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

recommended for all projects, though small projects may not receive as much benefit as there are typically fewer decisions and options to consider on small projects.

How to Use It?

The agency, contractor, or designer requests an in-progress design workshop in advance of the desired workshop date. This enables the contractor and/or the designer to submit drawings or other documents for review during the workshop. The workshop may focus on a specific discipline or section of the project. Project team members associated with that design aspect—or whose discipline area may be affected by options and decisions discussed—should be included in the meeting. The in-progress design workshop is different than a design milestone review because the milestone review generally looks at the entire project and the design decisions made thus far. However, the in-progress design workshop focuses on a specific aspect so that the project team can discuss options before decisions are made.

The agency may choose to limit the number of in-progress design workshops held per week due to resource constraints. The agency should keep a written record of details, such as workshop participants, items covered, discrepancies and comments, planned corrective actions, and identified follow-up actions.

Synthesis of Examples

Ideally, this tool would be specified in the contract with details on who can call the meeting, the minimum lead time required, and who documents the meeting outcomes. Despite whether this tool is specified in the contract, it can be discussed at a partnering meeting. In-progress design workshop meetings are most successful when there is a continuity of team members, team members prepare for the workshop by reviewing documents, team members are actively engaged in the workshop, and team members who are knowledgeable in the disciplines being discussed are present and are able to make decisions for the project.

Example

I-15/I-215 (Devore) Interchange Improvements Project, California Department of Transportation

Although this is a D-B project, it provides helpful information on the implementation of in-progress design workshops. In-progress design workshops were used throughout this interchange improvement project, with description and requirements outlined in the *Project Requirements Book 2*, as follows:

> **In-Progress Design Workshops**
>
> Throughout the design process, the designer, builder, or the Department may request (with at least [5] Working Days' notice) in-progress design workshops to discuss and verify design progress and to assist the designers in resolving design questions and issues.
>
> At least [5] Working Days prior to each in-progress workshop, the designer shall assemble and submit drawings or other documents to be reviewed during the workshop to the Department for its information and review.

(continued on next page)

The designer shall maintain a written record of all in-progress design workshops, including:

- A list of the participants in attendance, date, time, and location;
- Description of the items covered and discussed;
- Identification of discrepancies and comments and a report on corrective actions (both those taken and those planned); [and]
- Identification of follow-up action items, due dates, the party responsible for action items requiring resolution, and deadlines for resolution.

References

California Department of Transportation. Preconstruction Services Contract Interstate 215 Barton Road Interchange Reconstruction Project, Construction Manager/General Contractor Services. 2015. www.caltrans.ca.gov/hq/oppd/cmgc/awarded/SBd-215-Barton-PSC-Posted.pdf. Accessed August 29, 2017.

16 Deviations from Agency Standards

The agency allows deviations from standards on a specific project when it makes sense in the context of that project.

What Is It?

Instead of automatically following all standards, the project team evaluates project goals and project context and, when appropriate, suggests deviations from standards in order to better meet the agencies' goals. This does not apply to safety standards.

Why Use It?

Standards are meant to apply to a wide variety of circumstances. The circumstances of a particular project may not be similar to the circumstances for which the standard was created.

A deviation from agency standards can help design decisions that better target project needs in a more efficient manner. Because each project has a unique set of goals and circumstances, some agency standards should be adjusted to accommodate a specific project. This removes any unnecessary barriers that could potentially prevent project goals from being reached.

Potential benefits include cost savings and schedule acceleration through eliminating the effort that goes into complying with standards that do not apply. This flexibility of selecting appropriate standards also encourages contractor input during preconstruction, which can enhance constructability, innovation, value engineering, and risk mitigation. The agency maintains control over design by determining what deviations from standards will be allowed.


ALIGNMENT


PRECONSTRUCTION QUALITY

The deviations from agency standards tool addresses the Alignment Strategy and the Preconstruction Services Quality Strategy. Clearly identifying what standards are to be met and what standards are being modified helps create alignment among the project team. Active participation from the designer, CM-GC, and owner in determining appropriate deviations from agency standards is part of preconstruction services quality.

When to Use It?

This tool is used during design when the project team is making design decision. The decision to accept a deviation from agency standards is made during the design phase. However, those decisions are implemented during the construction phase of the project. This tool is recommended for medium to large projects that are moderate to complex (Table A.18). It is not

Table A.18. Recommended uses for deviations from agency standards.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
16 Deviations from Agency Standards		✓	✓			◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

recommended for smaller, noncomplex projects, as it may not produce a big enough benefit to justify the time and expense of analyzing potential deviations from the standards.

How to Use It?

As the design team becomes thoroughly immersed in the project details, it can look for general standards that may not be meeting project goals efficiently. Then the project team brainstorms alternatives to the standard, and it can perform a cost–benefit analysis on the alternatives. A top alternative is then selected and presented to the agency as an alternate to the design standard. The agency has the authority to accept or reject the deviation from the agency standard.

For example, a culvert crossing may require a certain cross section that the agency does not have a standard design for. If another state has a standard for that cross section, the agency can adopt that standard. Both standards are approved by a structural engineer, but the deviation allows the sizing to fit the need better. Agencies might have regulations prohibiting work noise during certain hours or a requirement to keep a certain number of lanes of traffic open. An agency may consider a deviation from these regulations for a limited amount of time if there is a justifiable benefit to the project and the public.

In general, an agency will want to avoid accepting a deviation from agency standards that reduces scope or reduces function. For example, substituting a pavement with a shorter life for the standard with a longer life would not be a benefit to the lifecycle cost of the facility.

Synthesis of Examples

This tool **should not be used to avoid** meeting functional, quality, safety, or other agency standards. Allowing deviation from a standard can be used to help manage risks but should not compromise the final constructed product. For example, an agency may typically place some risk as a responsibility of the contractor. Allowing a deviation—and sharing and qualifying the risk—can help reduce the cost of the work by reducing the contractor's contingency for the work. Any deviations under consideration should be carefully thought through and documented if agreed upon. Deviations should bring a benefit to the agency and not just be a convenience for the construction.

Example

Winona Bridge Project, Minnesota Department of Transportation

This project rehabilitated an historic bridge across the Mississippi River. The standards called for cofferdams to be at the 10-year flood elevation. Instead, the project team built the cofferdams to 1 foot above the 5-year flood elevation. By accepting this risk, the project saved $240,000, as summarized in the following project case study:

> **Mississippi River Spring Flooding**
>
> One of the main project goals is to place Trunk Highway 43 traffic on new Bridge 85851 by the fall of 2016. In order to accomplish this, the project team needed to devise a plan to mitigate the potential risk of Mississippi River flooding in the spring of 2015, which could cause a significant delay and potentially unrecoverable schedule delay to the project. With recent river flooding in the spring and summer of 2014, this was a major concern for the project team.
>
> The primary countermeasure to address this risk was an aggressive construction schedule for the new bridge river piers: build them up out of harm's way before the spring 2015 flood season. The team worked proactively toward this common goal.
>
> Several cost mitigation techniques were also deployed once the schedule details were worked out:
>
> - The cofferdam elevations were set at a 5-year flood elevation—plus 1 foot—in lieu of a 10-year event level, resulting in the project savings of $240,000.
> - A unique, shared-risk marine idle equipment contract provision was deployed to pay the contractor for any idle marine equipment should flooding in 2015 impact the critical path of the construction schedule. This could save up to an additional $250,000 if the project stays on schedule and experiences no flooding delays in the spring.
>
> When combined, these savings could lead to an overall cost savings of $490,000 for the project.

References

Minnesota Department of Transportation. *Benefits of the Construction Manager/General Contractor (CMGC) Delivery Method*. 2015. http://www.dot.state.mn.us/winonabridge/docs/casestudies/casestudy8.pdf. Accessed December 21, 2017.

17 Over-the-Shoulder Reviews

Over-the-shoulder review meetings bring the designer and the agency together to look at and discuss design documents while these designs are progressing.

What Is It?

Over-the-shoulder reviews are informal design reviews where designers and agency representatives talk about design assumptions, project constraints, and alternative design solutions prior to formal design submittals. These meetings are an opportunity for the agency to provide input to the designer before design decisions are documented in a formal submittal (Gransberg et al. 2008). These types of design reviews mainly assess whether the designer is properly meeting the design requirements and design criteria of the contract. In addition, these reviews can address whether the design quality management plan activities are occurring in accordance with the agency approved, contractor-developed, quality management plan, as well as overall project quality requirements (Gransberg et al. 2008).

Why Use It?

An agency can use over-the-shoulder reviews to provide feedback to the designer sooner than a formal submittal, thus avoiding incomplete design work or redesign. Designers can receive agency feedback where it is desired and helpful (Gransberg et al. 2008). Design does not need to stop for an over-the-shoulder review as it would for a formal submittal and review. An over-the-shoulder review provides review input and opportunities to resolve confusion and conflicts without pausing the design progress. Additionally, over-the-shoulder reviews can help to increase the contractor's adherence to required criteria, increase the quality of the design, and, in turn, increase the quality of the constructed project.

Potential benefits include schedule acceleration and owner control of design. Over-the-shoulder reviews allow the agency to stay involved in the design process and can prevent designers from pursuing alternatives that will not meet the agency's needs.

Over-the-shoulder reviews address the Alignment Strategy and the Preconstruction Services Quality Strategy. Alignment is refined as the project team discusses the project during over-the-shoulder reviews. The reviews encourage active participation of the contractor during design.

When to Use It?

This tool can be used throughout the design phase. Over-the-shoulder design reviews can be prioritized on design aspects that are on the critical path (Gransberg et al. 2008). Over-the-shoulder meetings are helpful in checking specific design criteria. Projects with strict or difficult performance and design criteria can benefit from the communication that occurs in an over-the-shoulder meeting. Some agencies conduct regularly scheduled over-the-shoulder reviews.

Over-the-shoulder reviews are recommended for projects of any size and when projects are moderately complex to complex (Table A.19).

How to Use It?

The use of over-the-shoulder reviews should be stated in the RFP, along with guidelines on how to initiate, structure, and document an over-the-shoulder meeting. Over-the-shoulder meetings should be collaborative for optimal benefit. The agency can initiate over-the-shoulder meetings at any time, or the meetings can be part of the project schedule. Over-

Table A.19. Recommended uses for over-the-shoulder reviews.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
17 Over-the-Shoulder Reviews		✓	✓			◗	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

the-shoulder meetings can be group meetings or one-on-one conversations. The designer should implement the feedback, but, generally, it is not required to provide written documentation of the feedback.

Synthesis of Examples

The expectation to implement over-the-shoulder reviews should be made in the RFP and in the contract. Project teams can hold regularly scheduled over-the-shoulder reviews, or they can call special meetings when a design issue arises. In general, over-the-shoulder reviews should not wait until a design milestone submittal. Over-the-shoulder reviews can help facilitate communication between discipline reviewers in the agency and the design team. Over-the-shoulder reviews will help the agency expedite the review of milestone submittals.

Example 1

Winona Bridge Project, Minnesota Department of Transportation

With this CM-GC project, Minnesota DOT built a new box girder bridge over the Mississippi River and restored a historic truss bridge. The State Historic Preservation Office and FHWA were involved. The historic, environmental, and community concerns introduced many challenges and specifications. Minnesota DOT used over-the-shoulder meetings to facilitate communication among the team members. Over-the-shoulder meetings also ensured that requirements would meet all design decisions and that constructability issues would be considered in the design.

Example 2

I-15/I-215 (Devore) Interchange Improvements Project, California Department of Transportation

Although this example is from a D-B project, the specification used for over-the-shoulder reviews is a useful reference for CM-GC projects. The Devore Interchange

(continued on next page)

was a complex D-B project. To facilitate communication about the project schedule and project quality, Caltrans offered to meet with the designer to review the design in progress before formal submittal. The process of over-the-shoulder reviews was described in the *Project Requirements Book 2*, as follows:

> **Over-the-Shoulder Reviews**
>
> Over-the-shoulder reviews are informal examinations by the Department of design documents during the Project design process. Over-the-shoulder reviews will mainly assess whether the requirements and design criteria of the Contract documents are being followed and whether the Design–Builder's Design Quality Management plan activities are being undertaken in accordance with the approved Quality Manual.
>
> Each design package may have multiple over-the-shoulder reviews at the request of either the Department or the Design–Builder. The reviews may, at the Department's discretion, include review of design drawings, electronic files, calculations, reports, specifications, geotechnical data, progress prints, computer images, draft documents, draft specifications and reports, other design documents, and any other relevant design information as requested by the Department.
>
> It is the intent of these reviews to check for concept, level of detail, design criteria, and fatal flaws. Comments made by the oversight team will be considered nonbinding. It is the Design–Builder's responsibility to conform to the Contract requirements. These reviews will not routinely include detailed calculation or drawing reviews, although the Department retains the right to perform detailed reviews of any item at any time. If mutually agreed upon between parties, for specific review items, the over-the-shoulder review may consist of an exchange of electronic files between the Design–Builder's designer and the Department.
>
> The Design–Build shall permit over-the-shoulder reviews by the Department during the course of the development of each design package, prior to issuance of Released for Construction Documents. The over-the-shoulder reviews are not critical activity points that restrict the progress of design. They are simply reviews of the design as it progresses and opportunities for the Department to provide comments and feedback on the design. The Quality Manager shall define the Plan and format of the over-the-shoulder reviews, as mutually agreed.

References

California Department of Transportation. *Design–Build Demonstration Program Quality Manual Outline.* July 2013. http://www.dot.ca.gov/design/idd/db/sac50-5/rfp/03-2F21U4-Exhibit-2A-Quality-Manual-Template.pdf. Accessed February 12, 2017.

Gransberg, D. D., J. Datin, and K. Molenaar, *NCHRP Synthesis 376: Quality Assurance in Design–Build Projects.* Transportation Research Board of the National Academies, Washington, D.C., 2008.

18 Open-Book Estimating

The contractor's estimating records are open for the agency to review and audit to ensure that competitive pricing for the project is achieved.

What Is It?

Estimating records are kept by the contractor and made open to the agency for review and audit. This allows the agency to verify that competitive pricing is achieved during design. During construction, reviews and audits of pricing verify that adequate progress is being made and that a fair price is being paid.

Why Use It?


ALIGNMENT

Open-book estimating helps to document project estimates and expenses. It demonstrates that the agency is obtaining fair market value for the work. Fair market value is evaluated by keeping corporate overhead and profit separate from the indirect costs in the cost model. Potential benefits from open-book estimating include cost savings and early knowledge of costs. Open-book estimating addresses the Alignment Strategy by helping to keep costs within the agency's budget.

When to Use It?

Open-book estimating and pricing are used throughout preconstruction and construction (Table A.20).

How to Use It?

Costs are categorized into different groups, including direct costs, indirect costs, contingency, mobilization and demobilization, corporate overhead, escalations, and exclusions. These categories and descriptions help the contractor organize the accounting records. Self-performed and subcontracted work should be documented in a transparent way.

Synthesis of Examples

Agencies that use open-book estimating should develop a specification to help define the expectations for the agency and the contractor. The specification should address the following:

Table A.20. Recommended uses for open-book estimating.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
18 Open-Book Estimating			✓	✓		◗	●	●	◗	◗	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

- Policy regarding confidentiality of cost data,
- Estimated time scheduled when cost estimates are to be provided,
- Policy on how to address cost estimates that are deemed too expensive or greater than the project's budget,
- Required documentation to support the cost estimate,
- Expected content of the cost estimate,
- Agency definitions that are applicable to the cost estimate, and
- Format guidance (e.g., either an agency-specific format or industry referenced format).

Example 1

I-215 Barton Road Interchange Project, California Department of Transportation

Caltrans used an open-book approach on the I-215 Barton Road Interchange project to check cost estimates during design and to monitor cost during construction. In the cost model, the profit and overhead for self-performed work were applied at agreed-upon percentage rates. These percentages were not applied to individual direct cost items, but they were applied below the line to the total of all items. For subcontracted work, the subcontractor's profit and overhead were included with each indirect cost item, with the general contractor adding an agreed-upon profit percentage to the subcontracted work. The open-book estimate requirements were described in the preconstruction services contracts that follows:

4.0 Open-Book Estimating Requirements

4.1 Cost Model and Guaranteed Maximum Price Record Documentation Confidentiality:

The Construction Manager shall designate information it considers to be confidential. The Construction Manager shall clearly mark each page of documentation that the Construction Manager wants to remain confidential prior to submitting it to the Department.

If the Department receives a request for the confidential documents under the California Public Records Act, the Department will inform the entity requesting the documents of their confidentiality and notify the Construction Manager of the request.

4.2 Cost Model and Cost Estimates

1) Within 30 calendar days of the date of the Notice to Proceed, the Construction Manager shall review all available information regarding the design and scope of the project and, based upon that review, shall develop a Cost Model for the entire project for review by the Department. The cost model shall be prepared in a format agreed upon in advance by the Department and the Construction Manager. It will be based on the Department's list of standard pay items. The Construction Manager will work with the Department to develop the proposed form for the Cost Model and the GMP and obtain the Department's approval of the form or make changes in the proposed form, as requested by the Department.
2) During the review period, the Cost Model will be compared with the estimate prepared by Design and the Department estimate and/or Independent Cost Estimator [. . .] estimate. These estimates will be used to evaluate the Cost Model. The Construction Manager shall make adjustments to the Cost Model if required. Once approved by the Department, the Cost Model will be continually updated and kept current as the design progresses throughout the Preconstruction Phase until a GMP is agreed upon by both the Construction Manager and the Department. The Cost Model shall be the best representation of what the complete functional project's construction costs will be. The cost model shall not include the Construction Manager's Preconstruction Services Fee, sums due to Design, the cost of land,

right of way, or other costs [that] are the responsibility of the Department. The Construction Manager shall communicate to the Project Team any assumptions made in preparing the Cost Model. The Cost Model may include allowances as agreed to by the Project Team, including

a. allowances for potential additional quantities and/or additional work that the Department may require, and
b. any costs related to investigations.

3) After receipt of the Department's most current documents from each design milestone, the Construction Manager shall provide a detailed written report to the Project Team regarding the impact of and changes to the Cost Model based on the Construction Manager's review of design documents made available at the design milestone. The Project Manager and the Construction Manager shall reconcile any disagreements on the estimate to arrive at an agreed-upon estimate for the construction costs based on the scope of the project through that design milestone. The design milestones applicable to this paragraph are 90 [percent] design and Final design. If the Project Team requires additional updates of the Cost Model beyond that specified in this paragraph, the Construction Manager shall provide the requested information in a timely manner.
4) If, at any point, the Cost Model submitted to the Department exceeds estimates previously agreed upon by the Project Team or the Department's Project Budget, the Construction Manager shall make appropriate recommendations to the Project Manager on means/methods, materials, scope, and/or other design elements that [the Construction Manager] believes will reduce the estimated construction costs (without altering the Department's overall concept) such that it is equal to or less than the established Project Team's target and/or the Project Budget.
5) Each Cost Model submitted shall be accompanied by backup documentation, which shall include the following:
   a. Unit prices and quantity take-offs using the Department's standard pay items; [. . .]
   b. Details of all allowances and unit price work shown and specified in the detailed design documents; [. . .]
   c. Material costs, equipment costs, labor costs, General Conditions costs, hourly labor rates, and total cost. Labor costs in the Cost Model shall include employee benefits, payroll taxes and other payroll burdens. The total cost for any portion of the work to be performed by subcontractors shall include subcontractor overhead and profit; [. . .]
   d. Production rates, transportation, and other facilities and services necessary for the proper execution of the work, whether temporary or permanent, and whether or not incorporated or to be incorporated into the work; [. . .]
   e. All fixed equipment, site improvements, utility and equipment installations; [. . .]
   f. Copies of quotations from subcontractors and suppliers; [. . .]
   g. Project overhead; [. . .]
   h. Allocated general and administrative expenses; [. . .]
   i. Bonds, taxes, insurance; [. . .]
   j. The Construction Manager's profit; and
   k. Memoranda, narratives, consultant's reports, and all other information included by the Construction Manager to arrive at the price shown in the Cost Model or GMP. Include a list of all assumptions and description and breakdown of all allowances.

(continued on next page)

4.3 Other Requirements

The following are minimum requirements for the Construction Manager when communicating cost via the open-book estimating process:

- The Construction Manager shall clearly delineate any services to be self-performed and any services to be subcontracted.
  - For self-performed work, overhead and profit percentages are to be identified, agreed upon, and applied to the total self-performed cost "below the line." This is opposed to allocating overhead and profit into individual direct cost items.
  - For work to be subcontracted, the subcontractor's overhead, profit, and indirect costs are to be included within the pricing of that individual direct cost item.
- Indirect costs are to be scoped, quantified, and priced as a separate division of cost and are not to be allocated under direct costs, except as stated above for work performed by subcontractors.
- Mobilization/demobilization of temporary job site offices is to be a detailed item, and the Construction Manager shall include this under indirect costs.
- Mobilization/demobilization of construction equipment is to be an individually detailed item for each piece of equipment, all of which is to be included under direct costs.
- Overhead and profit are to be applied as follows:
  - Overhead is to be priced as a percentage of the total of indirect costs and direct costs.
  - Profit is to be divided and identified into two categories:
    - A percentage applied to self-performed work and
    - A percentage applied to subcontracts.

The percentage applied to subcontracted costs is to be relatively low compared to the self-performed work.

- After all indirect, contingencies, escalation, overhead, and profit costs have been estimated and individually identified, each cost is to be allocated into pay items to establish the "all in" unit costs. Indirect costs, overhead, and profit are then to be distributed evenly into each pay item. Contingencies shall be specifically identified and allocated depending on risks associated with each pay item.

4.4 Definitions

The following definitions are provided to establish expectations regarding categorization and accounting to be represented in the open-book estimating process for the Project.

- Direct costs (construction) include
  - Self-performed work based on construction labor (e.g., craft wage rates burdened with fringe benefits only), equipment rental, equipment fuel/maintenance, and purchased materials;
  - Mobilization/demobilization of self-performed construction equipment; and
  - Subcontracted work, including each subcontractor's direct and indirect costs, overhead, profit, and bonds.
- Indirect costs (construction) include
  - Field supervision based on bare wages plus salary-related expenses for the project manager, superintendents, project engineer/project controls, and document control/administrator;
  - Jobsite office facilities, temporary utilities, and jobsite vehicles, including mobilization/demobilization of temporary facilities as separately-estimated items;
  - General field labor, clean-up requirements, dumpsters, dump fees, temporary toilets, [and so on];
  - Temporary construction facilities or work;
  - Yard support for construction equipment; and
  - Surveys, layout, permits, testing, inspection, and insurance.

- Contingency that is applied to an estimate during the preconstruction phase is based on an assessment of risk at each design phase, and it may be divided into several categories:
  - Design development to cover relatively minor changes in details, specifications, quantities, [and so on] from early design to 100 percent construction documents;
  - Estimate contingency to cover potential variances from what was estimated for materials and subcontracts compared to what was the actual cost of said materials and subcontracts;
  - Allowances for known items that cannot specifically be quantified and/or priced until further progress in design; [and]
  - Construction phase contingency for variations related to crew productivity, schedule impacts, etc. from what was originally estimated.
- Mobilization/demobilization costs are allocated as follows:
  - Mobilization/demobilization of self-performed construction equipment is considered a direct cost.
  - Mobilization/demobilization of jobsite office trailers, furniture, equipment, and personnel is considered an indirect cost. This also includes temporary utilities and elements required to begin construction, such as permits.
- Overhead is defined as home-office company overhead, including office facilities, management, subsidized insurance programs, paid vacation, [and so on].

Profit is defined as the operating margin or the dollars remaining after all direct and overhead costs are paid.

- Escalation shall be dealt with as follows:
  - Estimates will be based on wage rates and material costs that are current year at the time of pricing. Cost is added to cover normal expected increases for expenditures beyond the pricing baseline.
  - There are various methods for calculating escalation. The most accurate for labor increases is to manpower-load the construction schedule for all labor types and add agreed-upon dollar increases for each calendar period in which each apply.
- Exclusions are defined as items that are associated with the Project but provided by others. This may include items provided by
  - The Department,
  - Utility companies, [and]
  - Work done by adjacent contractors.

Example 2

E-470 Widening Project from Cherry Creek to Quincy Avenue Project, E-470 Public Highway Authority

This project utilized open-book cost estimating, and the requirements were described in the RFP. The introduction of these requirements is provided below:

Exhibit D

(Open Book Cost Estimating Requirements)

Introduction

Throughout Pre-construction, and as changes demand during the Construction Phase, the Construction Manager/General Contractor (CM/GC) shall provide estimates of (Project) cost and/or cost of individual Project elements. The estimates shall be prepared in a transparent, detailed, open book format that

(continued on next page)

allows the Owner and his representatives to understand the basis of costs and cost development. The estimates shall be prepared in the CM/GC's cost estimating system in customary used by the CM/GC for other projects of similar nature. The estimates are to be developed using current pricing for wage and equipment rates (material pricing will depend on how quoted and the amount of time for which the quote is fixed). Since some estimates will not have the pricing for all material suppliers and subcontractors to enable firm fixed pricing, there may be limited items of plug pricing, which should be noted as such. As the estimates are successively refined, the plug pricing will be replaced by firm prices in using competitively selected subcontractors and material suppliers.

Submitted estimates shall clearly itemize the estimated costs of performing the Work of the items in the mutually agreed schedule of values and also the Contractor's field indirect items. A summary level cost is requested for each of the items provided, supported by a detailed cost of each item. The detail shall provide crews with rates of production for each activity within the item ow Work. Crews shall clearly show the number of equipment and personnel within each activity and work hours for overtime calculations. Estimates of cost for items of Work shall be further divided into the Contractor's customary cost categories such as man-hours, labor, permanent materials, expendable materials, equipment ownership and operation, and subcontract cost, as appropriate. The detail of the Work breakdown may include several activities within a schedule of value line item that shall subtotal to a one-line entry for the summary report. The summary shall include the same cost categories along with the unit cost of the total. Further groupings of similar items of Work can be agreed upon to further facilitate reconciliation of Owner and Contractor Estimates.

References

California Department of Transportation. Preconstruction Services Contract Interstate 215 Barton Road Interchange Reconstruction Project, Construction Manager/General Contractor Services. 2015. www.caltrans.ca.gov/hq/oppd/cmgc/awarded/SBd-215-Barton-PSC-Posted.pdf. Accessed August 29, 2017.

19 Public Announcements

Public Announcements—such as through an agency newsletter—explain to the public what a CM-GC is and the benefits it offers a specific project.

What Is It?

This tool is a project newsletter distributed to individuals or to groups interested in the project and/or posted on a project website. Project newsletters have traditionally been used to share information on progress updates, traffic switches, road closures, and the opening of new facilities. However, this tool focuses on the use of a project newsletter to inform the public about what a CM-GC is and the benefits it is bringing to a project. Examples of project benefits include improvements to cost, schedule, quality, safety, and access.

Why Use It?

The agency implements this tool to inform the community about project progress and how the delivery method is yielding positive results. The project newsletter provides general information to the public, answers typical questions, and explains the benefits of using a CM-GC. This communication builds understanding, trust, and community support for the project.


ALIGNMENT

Potential benefits from public support include avoiding delays and agency control of how information is presented to the public.

Public announcements address the Alignment Strategy by helping to communicate with the public about project goals and by establishing positive relationships.

When to Use It?

Project newsletters can be used at any time during the project. They can be especially helpful in highlighting significant project delivery benefits. They can also be used in conjunction with open houses. When a project is completed and open to the public, a newsletter can be sent to thank the public for their patience during construction and to reiterate the benefits of CM-GC. Public announcements are not needed on every CM-GC project or at every phase. They should only be used when there is a specific reason to make a public announcement. In general, the public is interested in how a project benefits a community and the cost and schedule. However, care should be taken not to confuse the public with details of CM-GC delivery or to debate with opponents of CM-GC delivery. Regarding the use of public announcements, one experienced contractor said, "Do it very selectively when there is a specific reason and a very specific proactive outcome desired from the announcement so as not to open up debate that's not value added or risk the project or certain innovations."

This tool is recommended for projects of medium to large size and from moderate to complex projects (Table A.21). Smaller projects may also benefit if there is some special impact the public will experience due to the CM-GC contracting method.

How to Use It?

Share project newsletters with the public and the media. They can be distributed via email, in paper form at public meetings, and on the project website.

Synthesis of Examples

Public announcements related to CM-GC can take the form of special articles and sections developed for newsletter, blogs, and various forms of electronic communications

Table A.21. Recommended uses for public announcements.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
19 Public Announcements		✓	✓	✓	✓	○	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

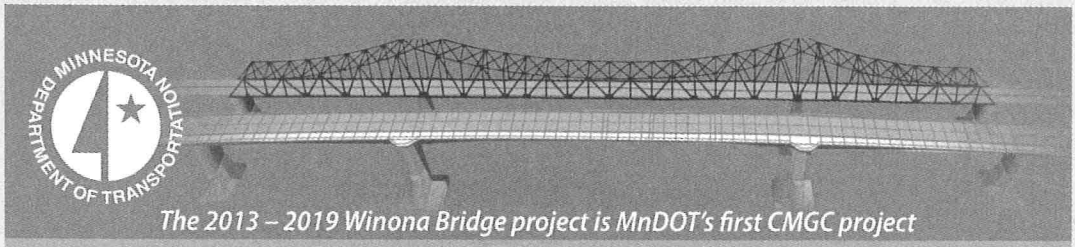
(e.g., social media). Public announcements related to CM-GC are usually integrated into other project-related public announcements. It is important for the announcement to explain how CM-GC differs from other types of project delivery methods, especially the traditional approach of design–bid–build. Content of CM-GC–specific public announcements include, but are not limited to

- Explanation of CM-GC,
- Benefits of using CM-GC,
- Justification for using CM-GC on the project, and
- Identification of the CM-GC contractor.

Example 1

Winona Bridge Project, Minnesota Department of Transportation

Minnesota DOT distributed project newsletters on the Winona Bridge Project that highlighted the benefits of CM-GC. The newsletters provided a brief definition of CM-GC and the general benefits of using the method, followed by a description of how specific benefits manifested themselves.



The 2013 – 2019 Winona Bridge project is MnDOT's first CMGC project

BENEFITS OF THE CONSTRUCTION MANAGER/GENERAL CONTRACTOR (CMGC) DELIVERY METHOD

WHAT IS CMGC?

In the **CMGC** process the project owner hires a contractor to provide feedback during the design phase before the start of construction. It's an alternative contracting method to Design-Bid-Build or Design-Build.

DESIGNER ····· CONTRACTOR

The CMGC method is also called **"CONSTRUCTION MANAGER AT RISK"** (CMR).

CMGC is relatively new to the transportation industry.

2014: THE WINONA BRIDGE PROJECT WAS MNDOT'S 1ST CMGC PROJECT.

CMGC is one of **THE FEDERAL HIGHWAY ADMINISTRATION'S EVERY DAY COUNTS** (EDC) initiatives being furthered as an accelerated project delivery method.

THE EDC INITIATIVE is designed to identify and deploy innovation aimed at reducing the time it takes to deliver highway projects, enhance safety, and protect the environment.

2 PHASES

HOW DOES IT WORK?

THE CMGC PROCESS IS BROKEN DOWN INTO 2 CONTRACT PHASES:

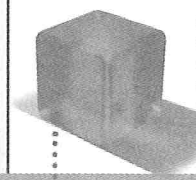
In the **1ST** contract phase, **THE DESIGN PHASE,** the contractor works with the designer and the project owner to identify risks, provide cost projections, and refine the project schedule. Then, the contractor and project owner negotiate on the price for the construction contract. If all parties are in agreement with costs, then the **2ND** contract phase, **THE CONSTRUCTION PHASE,** is kicked off and construction begins.

WHY CMGC INSTEAD OF A TRADITIONAL DELIVERY METHOD?

CMGC HELPS SAVE TIME IN 4 PRIMARY AREAS:

- Can begin the project earlier
- Design takes less time
- Construction takes less time
- Overlapping design and construction reduces project time

INDEPENDENT COST ESTIMATOR (ICE)

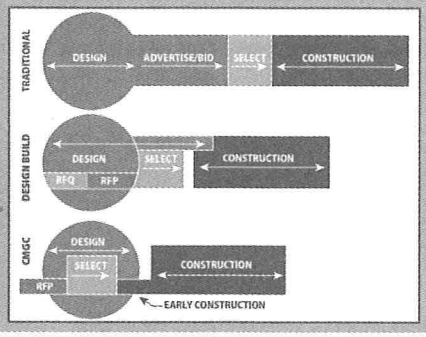


In the CMGC bid process, an **INDEPENDENT COST ESTIMATOR (ICE)** separately estimates the costs for different parts of the construction, to compare with the bid the CMGC submits. The CMGC's bid must be within 10% of the independent cost estimator in order to be accepted.

BENEFITS

WHAT ARE THE BENEFITS OF CMGC?

- **FOSTERS INNOVATION**
- **ALLOWS FLEXIBILITY**
- **IMPROVES COST CONTROL AND COST CERTAINTY**
- **FEWER CHANGE ORDERS AND OVERRUNS**
- **HIGHER DESIGN QUALITY**
- **REDUCES RISK**
- **OPTIMIZES SCHEDULES**
- **ENHANCES COLLABORATION**
- **UPFRONT VALUE ENGINEERING**
- **IMPROVES CONSTRUCTABILITY**
  (The design only includes features that can be built.)



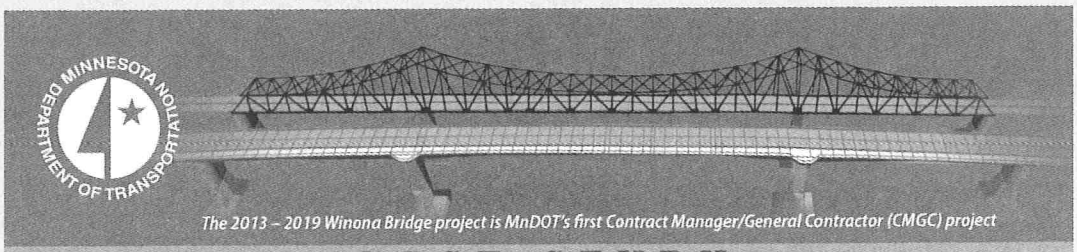
CMGC IMPACTS ON THE WINONA BRIDGE PROJECT

- **REDUCED THE COMPLEXITY OF DEALING WITH MULTIPLE CONTRACTORS**
- **AIDED IN WINONA COMMUNITY INVOLVEMENT**
- **MAKES RENOVATION OF THE ADJACENT HISTORIC BRIDGE MORE PREDICTABLE**
- **ALLOWED EARLIER ENGAGEMENT OF THE HISTORICAL TEAM**
- **REDUCED RISKS**

AMES CONSTRUCTION IS THE WINONA BRIDGE CMGC CONTRACTOR

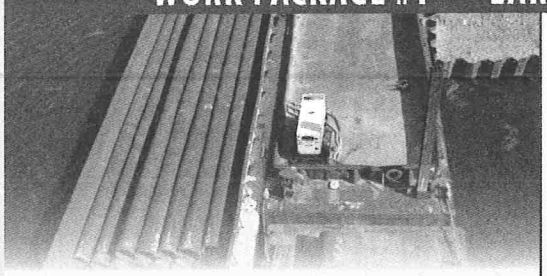
Also the **GENERAL CONTRACTOR** on the nearby Dresbach Interchange project (shown). **OUTSTANDING SAFETY RECORD.** History of **QUALITY BRIDGE PROJECTS, ON-TIME DELIVERY, AND PROFESSIONALISM.**

Ames Construction, Inc.®



CASE STUDY

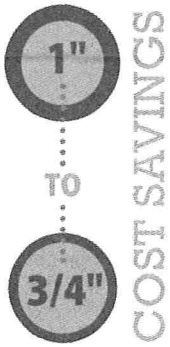
WORK PACKAGE #1 — EARLY PILING PROCUREMENT



EARLY PROCUREMENT MITIGATED THE RISK OF SCHEDULE DELAYS

Early in MnDOT's work with **AMES CONSTRUCTION, INC.,** the CMGC contractor, an additional work package was implemented to procure new bridge foundation pilings. The new Work Package #1 consisted of **PROCUREMENT OF 42-INCH OPEN-ENDED STEEL SHELL PILINGS** for the new bridge main river pier substructures.

Through the CMGC process, **AMES WORKED DIRECTLY WITH THE STEEL PILING FABRICATORS** and determined a 12-20 week lead time was required for the pilings to be fabricated and delivered. A main project goal is to advance construction so the **SPRING 2015 FLOODING ON THE MISSISSIPPI RIVER** won't affect the scheduled goal of placing Highway 43 traffic on the new bridge by the fall of 2016. **EARLY PROCUREMENT OF THE PILINGS** was required to ensure delivery to the project site in August 2014, which allowed the river bridge foundation to proceed.



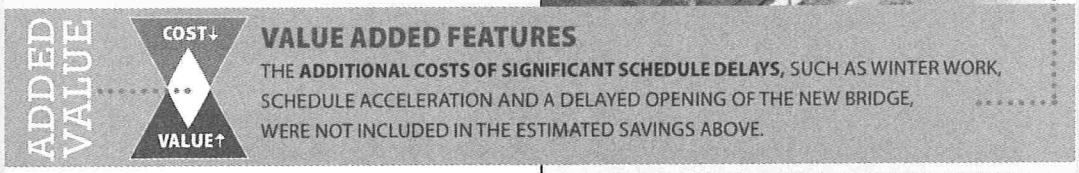
During constructability reviews, the CMGC team **RECOMMENDED CHANGING THE PILING WALL THICKNESS** from the originally recommended

1" TO 3/4"

This added **LENGTH TO THE OVERALL PILING QUANTITY** required, but it led to

$638,000

THE OVERALL COST SAVINGS ESTIMATED FOR THE DECREASE IN WALL THICKNESS OF THE PILING ON A $2.2 MILLION CONTRACT



VALUE ADDED FEATURES

THE **ADDITIONAL COSTS OF SIGNIFICANT SCHEDULE DELAYS,** SUCH AS WINTER WORK, SCHEDULE ACCELERATION AND A DELAYED OPENING OF THE NEW BRIDGE, WERE NOT INCLUDED IN THE ESTIMATED SAVINGS ABOVE.

FOR MORE INFORMATION ON THE WINONA BRIDGE PROJECT

TERRY WARD, PE, MSISE, PMP, PROJECT MANAGER
(507) 286-7688 • terry.ward@state.mn.us

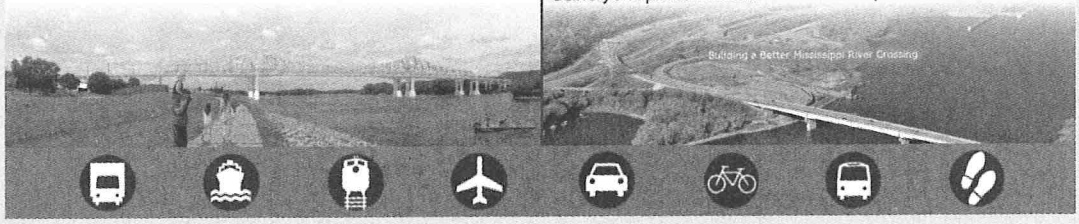
Or visit **WWW.MNDOT.GOV/WINONABRIDGE** and **WWW.FACEBOOK.COM/WINONABRIDGE**

AMES CONSTRUCTION IS THE WINONA BRIDGE CMGC CONTRACTOR

The Burnsville, Minnesota, company is also the **GENERAL CONTRACTOR** on the nearby **DRESBACH BRIDGE PROJECT** (shown).

A history of quality bridge projects, on-time delivery and professionalism.

Ames Construction, Inc.®



Example 2

Arizona Department of Transportation (Arizona DOT) Blog

Arizona DOT has used blogs to communicate information to constituents about CM-GC, also called construction manager at risk (CMAR). Arizona DOT used the following sample blog to introduce the basic concepts of the CMAR delivery method.

> **Arizona DOT Blog, Wednesday, May 22, 2013**
>
> **Construction Manager at Risk (CMAR) Method is Beneficial for Certain Projects**
>
> Typically, many [Arizona DOT] projects follow a common course: Design–Bid–Build.
>
> That means Arizona DOT (or a consulting engineer working for the department) designs the project, solicits bids, and then awards a contract to the lowest responsive and responsible bidder to build the project.
>
> While this method works well for many projects, some situations call for different options. . . . You might remember that we told you about one of those options—the Design–Build process—a while back. It involves pairing a design team with a construction team to create one team that works together and delivers a freeway project from beginning to end.
>
> But there are more than two ways to build a road, and, today, we're focusing on yet another alternative contracting method: Construction Manager at Risk.
>
> The Construction Manager at Risk method (or CMAR for short) allows [Arizona DOT] to select a designer and contractor separately. But instead of designing the entire project and then bringing on a contractor, CMAR lets [Arizona DOT] bring a contractor on board very early in the design process. During design, the CMAR contractor serves as an advisor and works closely with project designers. The relationships among the three key parties (e.g., owner, architect–engineering team, and the CMAR contractor) are collaborative, trusting, and nonadversarial. This kind of relationship produces a more manageable, predictive project, which saves time, money, and change orders.
>
> It also affords the designer an opportunity to tailor the design of the project to the CMAR contractor's preferred means and methods; provide more detail; and, potentially, reduce construction time.
>
> Another significant feature of the CMAR method is the guaranteed maximum price (GMP).
>
> The GMP is the total itemized dollar amount that the CMAR contractor guarantees to complete the project [. . .]. The amount is negotiated between the CMAR contractor and [Arizona DOT] and can include, but isn't limited to, a construction schedule, all traffic control, quality testing, survey replacement of materials, public information, and coordination costs. Projects can also have multiple GMPs for different portions of work.

(continued on next page)

When to Go with Construction Manager at Risk

If the CMAR method provides so many benefits, why isn't it used on every project? Well, not all projects are great contenders for CMAR.

CMAR is most beneficial when

- There is a need for immediate transportation improvements;
- The design is complex, difficult to define, subject to change, and/or has several design options;
- There is a high coordination requirement with external agencies that make cost overruns and construction schedule a pressing concern; [and]
- The project is sequence or schedule sensitive.

The method is less suitable for straightforward projects that are easily defined and lack schedule sensitivity.

When the project is all finished, drivers won't be able to tell which method was used; but having different options gives [Arizona DOT] the ability to build the state's highway system in a more effective manner.

References

Arizona Department of Transportation. CMAR Method Is Beneficial for Certain Projects. May 22, 2013. https://www.azdot.gov/media/blog/posts/2013/05/22/cmar-method-is-beneficial-for-certain-projects. Accessed September 23, 2017.

Minnesota Department of Transportation. *Benefits of the Construction Manager/General Contractor (CMGC) Delivery Method*. 2015. http://www.dot.state.mn.us/winonabridge/docs/casestudies/casestudy8.pdf. Accessed December 21, 2017.

20 Delegation of Authority

This agency action empowers the agency engineer in charge of a project to make project decisions that can have an impact on the project budget.

What Is It?

The agency delegates authority in writing—with specific limits—to the agency engineer managing the project. This enables some project decisions to be made quickly by personnel with specific project knowledge, even when these decisions may increase the project budget.

Why Use It?

The authority to execute agreements and increase the budget up to a designated amount is placed in the hands of the agency engineer in charge of the project. By delegating authority, the project team has confidence that project decisions will be made in a timely fashion so that schedule commitments can be met. Decisions made by those familiar with a project can avoid the unintended consequences that sometimes arise when decisions are made from those who are not involved in a project day to day.

Potential benefits include schedule acceleration, the ability to fast-track, and owner control of design.


SCOPE


PRECONSTRUCTION QUALITY

Delegation of authority addresses the Scope Strategy and the Preconstruction Services Quality Strategy. Clarity in responsibilities is part of the Scope Strategy, and delegation of authority clarifies that the responsibility of making timely decisions belongs to the agency engineer. Knowing that agency engineers have this responsibility encourages CMs to raise questions because CMs know that they are speaking with the decision makers.

When to Use It?

A memo delegating authority and specifying authority limits should be written at the end of the procurement process. The authority granted is in effect from design through closeout. This tool is recommended for projects of all sizes and complexities (Table A.22).

How to Use It?

Often an agency selects an alternative delivery method because it wants the project to have an accelerated schedule. To keep the project team advancing the project, decisions must be

Table A.22. Recommended uses for delegation of authority.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	<= $10 million	$10 million–$50 million	> $50 million
20 Delegation of Authority		✓	✓	✓	✓	●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

made quickly. Agencies often have an extended process for approving agreements and allocating additional funds. Delegation of authority to the agency engineer managing the project creates a streamlined process.

Synthesis of Examples

The delegation of authority should occur before it is needed, typically at the time of NTP. Extent and limitations of the authority should be clearly stated. The person given authority should be supported by upper management to use that authority. Some agencies associate the delegation of authority with their change order process, but it should be thought of as a broader authority that can address design exceptions and other agreements.

Example 1

Utah Department of Transportation Change Order Policy

This policy provides guidelines for the conditions and dollar amounts of change order approval for the resident engineer (RE), project manager, and regional director. An excerpt from the policy is shown below. Please refer to the Utah DOT website for the complete policy.

Resident Engineer Contingency

1. Negotiate with the project manager prior to advertising the amount that will be held as RE contingency on the project.
   a. This amount will be a minimum of $5,000 and a maximum of $25,000 per project and will be included as a non-bid item in the contract.
   b. Use RE contingency during construction to make minor adjustments to the contract for items that do not require a change order.
      1) These adjustments will not change the project scope beyond the project definition document, change specifications, add contract days, or exceed the RE contingency amount.
2. Document all RE contingency spent on an RE Contingency Documentation Form.

Example 2

Saint Louis District Safety Project, Missouri Department of Transportation (Missouri DOT)

Although this is a D-B project, the memo delegating authority provides a template of how this delegation can be structured for CM-GC. This project included 31 improvements across two counties. To help the state DOT remain nimble in responding to project team requests, the Missouri Highway and Transportation Commission delegated authority to the state DOT project director to execute agreements that were beneficial to the project. This gave the D-B team confidence that

project issues would be handled expeditiously by a knowledgeable Missouri DOT staff member. The contents of the memo delegating authority is shown below.

> **SUBJECT:** Delegation of Authority to [name], Project Director for the [Saint] Louis District Safety Improvements Design–Build Project in Franklin and [Saint] Charles Counties.
>
> The Missouri Highways and Transportation Commission at its August 2013 meeting delegated to the Chief Engineer position or his designee to approve and execute documents and expend funds on their behalf for the following items, except that nay change resulting in the expenditure of 2 percent over the project costs will be presented to the Commission.
>
> - **Escrow of Bid Documents**—Approve authority to execute agreements, affidavits, and related documents and expend funds for costs associated with the escrow of bid documents on the project.
> - **Agreements**—Approve authority to execute agreements with local governments including other entities for cost share, enhancements, use of property, environmental mitigations, utilities, etc. on the project, subject to approval as to form by Chief Counsel's Office and Commission Secretary attestation.
> - **Railroad Agreements**—Approve authority to execute agreements pertaining to railroads, subject to approval as to form by Chief Counsel's Office and Commission Secretary attestation.
> - **Construction Change Orders**—Approve authority to approve construction change orders on the project.
> - **Consulting Engineering Services**—Approve authority to execute contracts for engineering services needed subject to approval as to form by Chief Counsel's Office and Commission Secretary attestation.
> - **Other**—Approve Authority to expend funds for the project, as well as approve, execute, sign, and seal [project-specific] documents.
> - **Design Exceptions**—Approve authority to sign design exceptions specific to the design of the project currently delegated to the State Design Engineer and the State Bridge Engineer, subject to consultation with the department's technical experts.

References

Utah Department of Transportation. Change Orders UDOT 08B-10. Revised August 17, 2017. https://www.udot.utah.gov/main/uconowner.gf?n=10539014823834013. Accessed July 23, 2018.

21 Cost-Comparison Spreadsheet

A cost-comparison spreadsheet can be used to compare the estimates by the independent cost estimator, the CM-GC, the design team, and/or the agency's estimating division. The cost-comparison spreadsheet provides a line item-by-line item view of the estimated cost. The agency's project management team prepares the cost-comparison spreadsheet. Some agencies only share the names of line items where there are discrepancies. Other agencies share a percentage range—such as more than 10 percent difference—for specific line items. The exact percentage difference is generally not shared, as the goal is to generate discussion about assumptions that lead to the differences in estimates. It is not desirable for the contractor or independent cost estimator to default on a number to accelerate agreement. Tools related to the cost-comparison spreadsheet include the independent cost estimator, the cost-modeling approach, the OPCC process, and the CM–GC bid validation.

What Is It?

The cost-comparison spreadsheet reports percent range deviations between the independent cost estimator estimate and the CM-GC estimate. These estimates are referred to as blind estimates because they are not revealed to the other estimators.

Why Use It?

The cost-comparison spreadsheet is used to determine whether the CM-GC estimate is competitive, to verify estimating assumptions, to uncover discrepancies in assumptions, and as a basis for negotiating the construction agreed-upon price between the agency and the CM-GC.

The agency can use the information in the cost-comparison spreadsheet to facilitate a discussion of line item estimate differences with the CM-GC. Differences between the CM-GC estimate and the independent cost estimator estimate point to where assumptions and item quantities may need to be reviewed and clarified. The goal of this discussion is to develop cost conformity between the CM-GC and independent cost estimator estimates.

Potential benefits of the cost-comparison spreadsheet include cost savings, construction input in design to encourage constructability, innovation, and risk mitigation, early knowledge of costs, ability to bid early work packages, and facilitation of value engineering.

The cost-comparison spreadsheet addresses the Alignment Strategy, Scope Strategy, and the Preconstruction Services Quality Strategy. The discussion around variations highlighted by the cost-comparison spreadsheet helps bring alignment in budget, schedule, means and methods, and other project assumptions. Likewise, scope becomes more clearly defined, as do risks and the approach to mitigating those risks. The use of the cost-comparison spreadsheet promotes active participation of the contractor with the agency during the design phase.

When to Use It?

The cost-comparison spreadsheet is used during preconstruction to compare estimates for design milestones to ensure that the CM-GC's estimate is competitive (Table A.23). The cost-comparison spreadsheet is used whenever the independent cost estimator is used.

Table A.23. Recommended uses for cost-comparison spreadsheet.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
21 Cost-Comparison Spreadsheet			✓			◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

The cost-comparison spreadsheet has a row for every line item being estimated and a column for each of the estimates prepared by the entities: the CM-GC, the independent cost estimator, the agency, and/or the designer. The cost-comparison spreadsheet identifies percentage differences above or below a designated range. For example, a designated range could be 5 percent or 10 percent or some other percentage deemed suitable for the project. Deviations above or below the designated range are discussed and resolved. The estimates remain blind or unknown to other estimating parties, but the items with larger dollar value deviations are discussed. To focus the discussion, differences that occur in cost items that are small may not need to be discussed. For example, an item may show a high percentage deviation. But if the dollar value difference is small, it may not be important to discuss it. On the other hand, a deviation of a small percentage that leads to a high dollar value deviation would be something the agency should discuss. The focus is on achieving agreement on the total project cost and clarity concerning cost assumptions. Discussion may reveal assumptions or methods that need to be revised by the CM-GC or the independent cost estimator.

Synthesis of Examples

Cost comparisons utilize a spreadsheet that integrates the cost estimates from the CM-GC firm and the independent cost estimator or internal estimating program. The purpose is to examine where the variances between the external and internal agencies occur to facilitate communication and to better understand the reasons behind the difference. The spreadsheets can take many formats, but a general format is shown in Table A.24. Some agencies purposely keep the independent cost estimator or other internal price estimates confidential to avoid biasing the CM-GC cost estimates.

Table A.24. Example cost-comparison spreadsheet.

Item#	Description	Unit of Measure	Quantity	CM-GC Unit Price	CM-GC Total Cost	Internal Unit Price	Internal Total Cost	Variation (Above or Below Internal Estimate)
1	Item 1	CYD	5,000	$ 25.00	$125,000.00	$ 20.00	$100,000.00	$(25,000.00)
2	Item 2	CYD	2,000	$ 30.00	$ 60,000.00	$ 40.00	$ 80,000.00	$ 20,000.00
3	Item 3	Ton	500	$ 45.00	$ 22,500.00	$ 60.00	$ 30,000.00	$ 7,500.00
4	Item 4	LF	2,500	$ 3.00	$ 7,500.00	$ 2.00	$ 5,000.00	$ (2,500.00)

Example 1

I-70 Vail Overpass Project, Colorado Department of Transportation

Colorado DOT used a spreadsheet to compare the cost estimates prepared by the independent cost estimator and the CM-GC, as in the following excerpt. The "hide" columns are not shown to the CM-GC. Colorado DOT shared the last column with percentage deviation ranges. Discussion on assumptions and methods occurred on items with high deviations in percentage or cost. Cost comparisons were performed at all submittal milestones and helped the project keep the design in line with the budget.

Item No.	Description	Unit	Quantity	CM-GC Unit Price	CM-GC Total	Independent Cost Estimator Unit Price	Independent Cost Estimator Total	CM-GC – Independent Cost Estimator	(CM-GC–Independent Cost Estimator)/ CM-GC	CM-GC–Independent Cost Estimator
1	Item 1	Lump Sum	1	$2,000	$2,000	$1,900	$1,900	$100	5%	within 10%
2	Item 2	Each	50	$400	$20,000	$355	$17,750	$2,500	12.50%	↑ 10%
3	Item 3	Square Yard	1,200	$10	$12,000	$12	$14,400	($2,200)	-18.33%	↓ 10%

Example 2

Trunk Highway (TH) 53 Relocation Project, Minnesota Department of Transportation

Minnesota DOT used the following spreadsheet to compare the cost estimates prepared by the CM-GC and the independent cost estimator, as well as the CM-GC and the engineer's estimate (EE). Only the last column with percentage within and over was shared with the CM-GC. No dollar amounts are shared.

Cost-comparison spreadsheet with percentage difference.

Item No.	Description	Unit	Qty	Contractor's Estimate	ICE	Contractor/ ICE	Contractor/ EE
2021.501	Mobilization	Lump Sum	1	$26,300.00	$36,300.00	72.5%	Within 10%
2031.602	Combination Field Lab Office	Each	1	$10,000.00	$7,000.00	142.9%	Over 10%
2106.607	Common Excavation	CY	11,000	$74,000.00	$82,000.00	90.2%	Over 10%
2106.607	Common Embankment (CV)	CY	11,430	$84,000.00	$83,000.00	101.2%	Over 10%
2360.501	Wearing Course Mixture	Tons	700	$56,000.00	$48,000.00	116.7%	Over 10%
2360.502	Non Wearing Course Mixture	Tons	900	$63,000.00	$55,000.00	114.5%	Over 10%
2503.602	Connect to Existing Storm Sewer	Each	2	$9,000.00	$1,000.00	900.0%	Within 10%

Note: CV = compacted volume; CY = cubic yards.

Example 3

Sr-108; Sr-127 to Sr-107 Project, Utah Department of Transportation

This project utilized a cost-comparison spreadsheet to compare the CM-GC, the independent cost estimator, and the engineer's estimate. A portion of this template spreadsheet is shown below prior to the project values being documented.

Item No.	Description	Unit	Qty	CM-GC Direct Cost ($)	CM-GC (Item Totals)	ICE Direct Cost ($)	ICE (Item Totals)	CM-GC/ICE	EE Unit Price	EE Amount	CM-GC/EE
	General										
1	Mobilization	Lump	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
2	Traffic Control	Lump	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
3	Maintenance of Traffic	Lump	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
4	Silt Fence	FT	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
5	Gutter Inlet Barrier	Each	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
6	Environmental Control Supervisor	Lump	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
7	Dust Control and Watering	1,000 Gallon	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
8	Survey	Lump	1	$1.00	$1.00	$1.00	$1.00	Within Range	$1.00	$1.00	Within Range
	Subtotal				$8.00		$8.00	Within Range		$8.00	Within Range

Note: FT = foot.

References

AASHTO. *Practical Guide to Cost Estimating*, 1st Edition, Washington, D.C., 2013.

Minnesota Department of Transportation. *Draft CM/GC Interim Pricing (OPCC) Milestone Process*, Draft. 2013. www.dot.state.mn.us/const/tools/docs/cmgc-cost-estimating-process.docx. Accessed August 24, 2017.

22 Cost-Modeling Approach

This tool is a set of assumptions regarding construction means and methods that has been agreed to by the agency and the CM-GC. It is intended to produce uniformity in the estimating approach used by the CM-GC, the independent cost estimator, the agency, and the designer. Tools related to the cost-modeling approach include the independent cost estimator, the cost-comparison spreadsheet, the OPCC process, and the CM-GC bid validation.

What Is It?

A cost-modeling approach establishes a common set of assumptions about the means and methods to be used to construct the project. All estimators work from the same description of the work elements, assumptions about constructing those work elements, and baseline production rates. The team also develops a plan to communicate changes in scope, quantities, and phasing. The approach also includes a process for integrating construction manager design input, analysis, evaluation, and resolution into the design.

Why Use It?

Variances between estimates prepared by the CM-GC, the independent cost estimator, the agency, and/or the designer are minimized when a common approach to developing costs is implemented by all parties. This tool is especially helpful early in design to get the scope and budget reconciled. If realistic construction costs exceed the allowable budget, then the agency may consider reducing the scope of the project.

Potential benefits from the cost-modeling approach include cost savings and early knowledge of costs.

The cost-modeling approach addresses the Alignment Strategy, the Scope Strategy, and the Preconstruction Services Quality Strategy. The cost-modeling approach supports an iterative estimating process that helps align costs to budget and clarify construction assumptions. Misunderstandings about scope are uncovered and resolved, and the contractor is kept actively engaged with the agency throughout the design process. The process of developing a common cost-modeling approach establishes a uniform and accepted set of construction assumptions to be used for estimating by the CM-GC, the independent cost estimator, the designer, and the agency.

When to Use It?

A common cost-modeling approach should be developed for every project estimate. A cost-modeling approach meeting should be held soon after the CM-GC professional services contract is signed and before the first CM-GC cost estimate is submitted to the agency (Table A.25).

How to Use It?

Developing a cost-modeling approach begins with the project team members coming together to discuss assumptions about construction that impact cost. An initial cost-modeling approach meeting may last up to 8 hours. The construction manager, independent cost estimator, agency project manager, agency cost estimator, and any other project team members that the project manager deems appropriate should attend the meeting. Self-performed work and subcontracted items are identified, and percentages for the profit and overhead for self-performed work are established.

Table A.25. Recommended uses for cost-modeling approach.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
22 Cost-Modeling Approach			✓			◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Synthesis of Examples

It is important that an agency provide a CM-GC with a specification to describe multiple characteristics of the cost model, including the following:

- Time schedule when the initial cost model should be provided to the agency;
- Frequency as to when the cost model is to be updated, based on the project's progress;
- Prescribed actions to be taken when the cost model exceeds the agency's budget;
- Expected format and detail of the cost model; and
- Expected documentation to be provided with the cost model to help justify the estimated costs, which can include unit costs per the agencies standard code of accounts, contractor quotes, and narratives to describe unique project circumstances influencing either estimated quantities and/or costs.

Example 1

I-25 Barton Road Interchange Reconstruction Project, California Department of Transportation

Caltrans met with the CM-GC and the independent cost estimator to establish baseline production rates, as well as to discuss assumptions about construction means and methods that would impact project cost estimating and development of schedules. The meeting participants also established a communication plan to keep all parties informed about changes in project scope, quantities, and phasing. A description of the cost model and its requirements were described in the following portion of the Preconstruction Services Contract.

Cost Model and Cost Estimates

1) Within 30 calendar days of the date of the Notice to Proceed, the Construction Manager shall review all available information regarding the design and scope of the project, and based upon that review shall develop a Cost Model for the entire project for review by the Department. The Cost Model shall be prepared in a format agreed upon in advance by the Department and the Construction Manager. It will be based on the Department's list of standard pay items. The Construction Manager will work with the Department to develop the proposed form for the Cost Model and the guaranteed maximum price (GMP) and obtain the Department's approval of the form or make changes in the proposed form as requested by the Department.

(continued on next page)

2) During the review period, the Cost Model will be compared with the estimate prepared by the Design and the Department estimate and/or ICE estimate. The estimates will be used to evaluate the Cost Model. The Construction Manager shall make adjustments to the Cost Model if required. Once approved by the Department, the Cost Model will be continually updated and kept current as the design progresses throughout the Preconstruction Phase until the GMP is agreed upon by both the Construction Manager and the Department. The Cost Model shall be the best representation of what the complete functional project's construction costs will be. The Cost Model shall not include the Construction Manager's Preconstruction Services Fee, sums due to Design the cost of land, right of way, or other costs which are the responsibility of the Department. The Construction Manager shall communicate to the Project Team any assumptions made in preparing the Cost Model. The Cost Model may include allowances as agreed to by the Project Team, including
   a. Allowances for potential additional quantities and/or additional work that the department may require, and
   b. Any costs related to investigations.
3) After receipt of the Department's most current documents from each design milestone, the Construction Manager shall provide a detailed written report to the Project Team regarding the impact of and changes to the Cost Model based on the Construction Manager's review of the design documents made available at the design milestone. The Project Manager and the Construction Manager shall reconcile any disagreements on the estimate to arrive at an agreed upon estimate for the construction costs based on the scope of the project through that design milestone. The design milestones applicable to this paragraph are 90% design and Final design. If the Project Team required additional updates of the Cost Model beyond that specified in this paragraph, the Construction Manager shall provide the requested information in a timely manner.
4) If, at any point, the Cost Model submitted to the Department exceeds estimates previously agreed upon by the Project Team or the Department's Project Budget, the Construction Manager shall make appropriate recommendations to the Project Manager on means/methods, materials, scope, and/or other design elements that it believe will reduce the estimated construction costs (without altering the Department's overall concept) such that it is equal to or less than the established Project Team's target and/or Project Budget.
5) Each Cost Model submitted shall be accompanied by backup documentation, which shall include the following:
   a. Unit prices and quantity take-offs using the Department's standard pay items, and
   b. Details of all allowances and unit price work shown and specified in the detailed design documents, and
   c. Material costs, equipment costs, labor costs, General Conditions costs, hourly labor rates, and total cost[.] Labor costs in the Cost Model shall include employee benefits, payroll taxes, and other payroll burdens. The total cost for any portion of the work will be performed by the subcontractors shall include subcontractor overhead and profit, and
   d. Production rates, transportation, and other facilities and services necessary for the proper execution of the work, whether temporary or permanent, and whether [. . .] incorporated or to be incorporated into the work, and
   e. All fixed equipment, site improvements, utility, and equipment installations, and
   f. Copies of quotations from subcontractors and suppliers, and
   g. Project overhead, and
   h. Allocated general and administrative expenses, and
   i. Bonds, taxes, insurance, and
   j. The Construction Manager's profit, and
   k. Memoranda, narratives, consultant's reports, and all other information included by the Construction Manager to arrive at the price shown in the Cost Model or GMP. Include a list of all assumptions and descriptions and breakdown of all allowances.

Example 2

Colorado Department of Transportation *CM-GC Manual*

The Colorado DOT *CM-GC Manual* emphasizes the importance of clarifying pricing assumptions so that all parties involved in producing project estimates will base their work on an agreed set of assumptions. Assumptions may be general, such as a uniform set of labor rates; or they may be specific, such as detailed notes for line items. This cost approach was applied to the I-70 Vail Underpass, I-25–Arapahoe, and SH-82 Grand Avenue Bridge CM-GC projects.

Cost Model

Successful price justification in [CM-GC] relies on open communication to thoroughly document the assumptions used by the Contractor to price the work. The Cost Model is an open and transparent model that the Contractor develops and uses through the Preconstruction Phase so that estimates and assumptions are communicated to [Colorado] DOT, the Design Consultant, and the ICE. The Cost Model includes a Summary of Approximate Quantities (SAQ) for the Plans and Specifications at the time of the estimate, along with a list of the pricing assumptions and other notes associated with each bid item (see [Colorado] DOT Figure 3-6). Details include, but are not limited to, labor hours and rates, materials, equipment, subcontractor and supplier quotes, means and methods, production rates, risks, direct costs, and mobilization. The format of the Cost Model varies depending on the Contractor, but it must clearly communicate how the item costs were derived. [Colorado] DOT and the ICE review the Cost Model and must concur with the assumptions made by the Contractor.

[Colorado] DOT Figure 3-6 illustrates several example bid items from a Cost Model Summary of Approximate Quantities. Each bid item contains comments that document the assumptions associated with that item. These are reviewed by the project team and are agreed to by [Colorado] DOT to establish the terms for pricing the line item.

			QUANTITY	COMMENTS
ITEM NO.	ITEM	UNIT		
202-00035	REMOVAL OF PIPE	LF	53	REMOVAL OF PIPE JUST EAST OF DOGHOUSE RAIL BRIDGE, SEE SHEET 29. QUANTITIES HAVE BEEN ADJUSTED IN THIS SOAQ TO MATCH CP1A. ADDED 30 LF FOR REMOVAL OF 12" CMP AT CLEAR CREEK HOUSE DRIVEWAY.
202-00246	REMOVAL OF ASPHALT MAT (PLANING) (SPECIAL)	SY	935	1 MOBILIZATIONS FOR PROFILING CONTRACTOR. MUST GRIND OFF STRIPING.
202-00495	REMOVAL OF PORTIONS OF PRESENT STRUCTURE	LS	1	AREA 5 ALONG LENGTH OF THE WALL. REMOVE ROCKFALL FENCE ABOVE SHORING AREA 5.
202-XXXXX	REMOVAL OF GUARDRAIL (SPECIAL)	LF	1,270	TRANSPORT TO EMPIRE YARD
203-00062	EMBANKMENT MATERIAL (COMPLETE IN PLACE) (SPECIAL)	CY		EMBANKMENT VOLUME WITHIN AVERAGE END VOLUME AS SHOWN ON CLEAR CREEK CHANNEL CROSS SECTIONS.
203-02300	ROCK SCALER	HOUR	80	ADDED ITEM PER CDOT AT COST MODEL REVIEW MEETING
206-00100	STRUCTURE BACKFILL (CLASS 1)	CY	7,132	MOISTURE DENSITY CONTROL ABOVE WEST PORTAL
210-04020	MODIFY INLET	EACH	5	DECREASE QUANTITY PER CDOT/CONTRACTOR AT COST MODEL REVIEW MEETING TO MATCH FIELD CONDITIONS
210-XXXXX	MODIFY GUARDRAIL (SPECIAL)	LF	156	REQUIRES REMOVAL OF 156 LF OF GUARDRAIL (SPECIAL) AND RE-ANCHORING ROCKFALL FENCE.
217-00000	HERBICIDE TREATMENT	HOUR	100	REVISED QUANTITY DUE TO REQUEST FROM CDOT CM STAFF FOR ADDITIONAL HOURS NEEDED IN CP2
304-06000	AGGREGATE BASE COURSE (CLASS 6)	TON	1,518	REVISED QUANTITY DUE TO PARKING AREA AND CLEAR CREEK DRIVEWAY REVISION.
606-02005	END ANCHORAGE (FLARED)	EACH	2	IS REQUIRED TO BE PAINTED. AN EXISTING CDOT (SPECIAL) PAY ITEM DOES NOT EXIST, THEREFORE NEW ITEM WILL NOT BE REQUESTED. THIS IS CONSISTENT WITH PRIOR ITEM CREATION CONVERSATIONS REGARDING
626-00100	MOBILIZATION (WITHOUT AUTOPAY)	LS	1	8 MONTHS OF MANAGEMENT, 9 MONTHS OF OFFICE
700-71001	CMGC SHARED RISK CONTINGENCY POOL	FA	1	ADDED ITEM PER CDOT FOR COMMENTS
700-71002	CDOT RISK POOL	FA	1	ADDED ITEM PER CDOT FOR COMMENTS

Sample summary of appropriate qualities from a cost model (Source: Colorado Department of Transportation Figure 3-6).

References

California Department of Transportation. Preconstruction Services Contract Interstate 215 Barton Road Interchange Reconstruction Project, Construction Manager/General Contractor Services. 2015. www.caltrans.ca.gov/hq/oppd/cmgc/awarded/SBd-215-Barton-PSC-Posted.pdf. Accessed August 29, 2017.

23 Construction Manager–General Contractor Bid Validation

This tool is a process for checking the fairness of the CM-GC's bid proposal. Tools related to CM-GC bid validation include the independent cost estimator, the cost-modeling approach, the OPCC process, and the cost-comparison spreadsheet.

What Is It?

The CM-GC bid validation is the culmination of the opinion of the OPCC process. A bid can be prepared for the entire project, an individual severable work package, or long lead time procurement items. The agency validates the CM-GC's price proposal by comparing it with an independent estimate prepared by an independent cost estimator. The price comparison is performed using a cost-comparison spreadsheet.

Why Use It?

The CM-GC bid validation is a method for obtaining an independent estimate that serves as a stand-in for competitively bidding the work. The CM-GC bid validation process is aimed at focusing the agency and the CM-GC on resolving misunderstandings in assumptions. This open communication can build trust and helps set clear expectations for how the project will be built. Potential benefits include early knowledge of costs and cost savings and the ability to bid early work packages.

Validating the CM-GC price proposal ensures the CM-GC firm's proposed price is a fair market price. The agency can put the work out for bid if the CM-GC's price proposal is not deemed a fair market price.


ALIGNMENT


PRECONSTRUCTION QUALITY

The CM-GC bid validation addresses the Alignment Strategy and the Preconstruction Services Quality Strategy. This tool ensures that the agency and CM-GC are aligned with regard to the project's cost details. This tool is also the culmination of the preconstruction phase, in which the CM-GC provided input on the design and developed cost and schedule estimates. The CM-GC can develop a fair price proposal based on these factors.

When to Use It?

CM-GC bid validation is used at the end of the preconstruction services phase when the CM-GC is preparing a price proposal for the construction agreed price.

The CM-GC bid validation tool is recommended for moderate to complex projects that are more than $10 million in value (Table A.26). For smaller projects that are not complex, the project team can consider using this tool on a case-by-case basis.

How to Use It?

The agency can use an independent cost estimator or their own estimating group to prepare a bottom-up estimate similar to the way contractors prepare construction estimates. Some agencies develop both an independent cost estimator estimate and an internal agency estimate. The bid validation occurs at the end of an iterative OPCC process. The agency uses a cost-comparison spreadsheet to compare the independent cost estimator and/or the agency

Table A.26. Recommended uses for construction manager–general contractor bid validation.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
23 Construction Manager–General Contractor Bid Validation			✓			◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

estimate with the CM-GC estimate. Percentage range deviations between the estimates are noted. The agency is typically the only party that views the cost-comparison spreadsheet. The agency shares percentage range deviations with the CM-GC and the independent cost estimator and/or the agency's internal estimating group. Possible reasons for cost variations are discussed, and assumptions are clarified or revised.

The agency usually determines in advance how close to one another the CM-GC estimate and the independent cost estimator or the agency estimate must be to proceed with an agreement. The agency also determines how many revisions to the price proposal will be allowed before the agency puts the project out for bid. The cost and time necessary to bid a project should be factored into the decision of whether to accept a CM-GC proposal that is higher than the independent cost estimator estimate or the agency estimate.

Synthesis of Examples

The CM-GC bid validation process is typically described in the agency's CM-GC manual and includes the following steps:

1. The agency decides how far the design needs to advance to be able to establish a GMP.
2. The agency decides whether to require one GMP or multiple GMPs.
3. The agency or consultant develops a bid package to be used by the CM-GC in preparing the GMP proposal.
4. The independent cost estimator uses the same project documentation to prepare the independent estimate.
5. The CM-GC meets with the agency and design consultant to review the GMP proposal and all assumptions, including a breakdown of all allowances.
6. If the agency or consultant discover inaccuracies in the GMP proposal, the CM-GC is asked to adjust it along with its accompanying documentation.
7. The agency prepares a GMP comparison spreadsheet.
8. The agency reviews the project total and individual bid items for major discrepancies.
9. The agency accepts the GMP proposal when it is within a pre-established percentage of the independent cost estimator estimate.
10. The agency awards a construction contract once the GMP proposal is accepted.
11. Negotiations and an escalation ladder are recommended in case an agreement is not reached.
12. If an agreement is not reached, the agency puts the project out for bid.

Example 1

Arizona Department of Transportation *Construction Manager at Risk (CMAR) Process Guide*

GMP Proposal Review and Approval

Arizona DOT asks the contractor for a GMP proposal. The Arizona DOT CMAR manual provides the following guidelines. Note that Arizona DOT uses the CMAR acronym instead of CM-GC, but the process is similar:

> The CMAR Contractor shall meet with the Project Manager and Design Consultant to review any GMP Proposal and all supporting documentation. All Assumptions and Clarifications should be provided, as well as a description and breakdown of all allowances. In the event the Project Manager or Design Consultant discovers inconsistencies or inaccuracies in the information presented, the CMAR Contractor shall adjust the GMP Proposal and the accompanying documentation as necessary.
>
> The Construction Group may submit the same documents that were used by the CMAR Contractor in developing the GMP to an independent third party (Independent Reviewer).
>
> If the GMP Proposal is greater than the Department's estimate, the Department may require the CMAR Contractor to reconfirm the GMP Proposal. The CMAR Contractor may be requested, or at its own discretion, to submit a revised GMP Proposal for the Department's consideration.
>
> If agreement is not reached, the Department may elect to not enter into a separate contract with the CMAR Contractor for the Construction Phase.
>
> If the Department opts to bid the project under the normal bid process, the CMAR Contractor will not be allowed to submit a bid.
>
> If the Department elects to terminate the Preconstruction Services contract, or not enter into a Construction contract, or not enter into subsequent GMPs in the event that multiple GMPs are undertaken, the CMAR Contractor has no claim against the Department.
>
> If agreement is reached on a GMP, the State Engineer recommends to the Transportation Board that the GMP be awarded. This recommendation must be on the Board Agenda two weeks prior to the board meeting. Following board action, the Notice of Award is then issued. If the project has multiple GMPs, each GMP must be forwarded to the Transportation Board and separate Notice of Awards are issued for each GMP.

Example 2

Colorado Department of Transportation *CM-GC Manual*

CAP Proposal and Negotiations

Colorado DOT negotiates a construction agreed price (CAP) with the contractor. A description of the CAP and the negotiation process are described in their CM-GC manual. Key portions of the CM-GC manual are provided below:

> **Construction Agreed Price (CAP)**
>
> The Construction Agreed Price (CAP) is the maximum amount that will be incorporated into the standard CM-GC Construction Project Contract to accomplish the construction phase. The CAP is the sum of the direct

(continued on next page)

cost of construction and the CM-GC Management Price Percentage for a specific construction package. The total Contract Amount is the sum of the CAP and all established Risk Pools and Force Accounts. The basis for the CAP Proposal is the open-book Cost Model developed during the Preconstruction Phase and refined through a series of Opinion of Probable Construction Cost (OPCC) submittals and review meetings. The Contractor will propose a CAP and, if necessary, [Colorado] DOT and the Contractor negotiate the direct cost of construction for that package to agree on a final CAP. Multiple CAPs may be developed and accepted to facilitate project construction phasing or long-lead procurement items. Once a CAP Proposal is accepted by [Colorado] DOT, with Federal Highway Administration (FHWA) concurrence when required, the Contractor is awarded a construction contract to perform the work.

CAP Proposal and Negotiations

A CAP can be prepared for the entire project, a severable phase of the project, or for long-lead procurement items. The Contractor prepares a CAP Proposal once [Colorado] DOT and the Contractor have agreed that the design has advanced to a point to be able to establish a CAP. Typically, the design will be 90% complete or greater. Following the CAP, the Design Consultant is still responsible for completing a stamped set of 100% Plans, Specifications, and Estimate (PS&E). [Colorado] DOT is responsible for any changes that occur between the CAP and the 100% PS&E, and significant changes may require additional CAP negotiations. Therefore, all major items that affect pricing or schedule should be accounted for in the plans used to establish the CAP. If the project schedule allows, the plans may be advanced to 100% prior to establishing the CAP to reduce the risk of changes.

If a CAP Proposal is desired, the Design Consultant issues a CAP bid set of construction Plans and Specifications, along with the Summary of Approximate Quantities (SAQ) to be used by the Contractor when preparing the CAP Proposal. Alternatively, the Contractor may prepare the SAQ with [Colorado] DOT's approval and confirmation of the estimated quantities. [Colorado] DOT will prepare a comparison template based on the SAQ; therefore, when preparing the CAP Proposal and ICE Estimate, it is very important that the Contractor and ICE use the same SAQ and do not modify the format or reorder the bid items.

The [Colorado] DOT Project Manager prepares a Bid Package to be used by the Contractor in preparing the CAP Proposal. The Bid Package consists of the Plans, Specifications, SAQ, and all required Bid Forms. The Contractor prepares the CAP Proposal based on the Bid Package and open-book Cost Model that was refined during the Preconstruction Phase and the OPCC submittal process. The ICE Estimate uses the same project documentation to prepare their independent estimate. Both the CAP Proposal and ICE Estimate are submitted to the [Colorado] DOT Project Manager who prepares a CAP comparison spreadsheet. The comparison spreadsheet is used to identify price and percentage differences of the individual bid items and the total bid amount. This comparison spreadsheet is then sent to the review team, which typically consists of the Resident Engineer, Program Engineer, Engineering Estimate and Market Analysis (EEMA), Federal Highway Administration (FHWA), and ICE.

Acceptable Estimate Differences when Negotiating the CAP

The [Colorado] DOT Project Manager should review the overall project total and individual bid items for major discrepancies. [Colorado] DOT may accept the CAP Proposal when it is within a percentage of the ICE Estimate that is acceptable to [Colorado] DOT, with FHWA concurrence on Project of Corporate Interest (PoDI) projects. There is no set amount for an acceptable percentage. The acceptable percentage will depend on the overall project size and complexity, but it typically ranges from 2% to 10%. The acceptable percentage is not a contractual provision, but is determined by the Region for the specific project. The acceptable percentage shall be determined prior to entering into CAP negotiations.

The decisions to accept a CAP Proposal is a collaborative decision between the [Colorado] DOT Project Manager, EEMA, and the established review team. [Colorado] DOT must decide if any price differences will be saved if the project is competitively bid, recognizing that there are additional cost and schedule impacts involved with bidding the project.

Negotiations and the Escalation Ladder

If the percentage difference between the CAP Proposal and ICE Estimate is not acceptable to [Colorado] DOT, then CAP negotiations begin. The first CAP Proposal review is similar to the Cost Estimate Reviews performed during the OPCC submittal process. If the [Colorado] DOT Project Manager has not previously managed a CM-GC project, it is highly recommended that the [Colorado] DOT Project Manager requests the assistance of a manager with prior CM-GC CAP negotiation experience. During the initial negotiations, the [Colorado] DOT Project Manager, ICE, and Contractor attempt to reconcile pricing differences that are contributing to the pricing variance. The negotiations may take place in open forum meetings or through one-on-one discussions between [Colorado] DOT and the Contractor. As this stage, the [Colorado] DOT Project Manager should promote open and honest discussions to help resolve discrepancies.

After the initial negotiations the Contractor prepares a second CAP Proposal based on the results of the negotiations and any revision made to the Cost Model. The ICE again prepares an independent estimate using the revised criteria and the [Colorado] DOT Project Manager prepares a CAP Proposal comparison. If the CAP Proposal pricing differences have been resolved, then the CAP Proposal is accepted and [Colorado] DOT initiates the contracting process. If the percentage difference is not acceptable, then a second round of negotiations occurs. However, these negotiations should be elevated to a higher level of project management within the Contractor's organization and [Colorado] DOT, including the involvement of the Program Engineer and Region Transportation Director. Often a new perspective from senior management can open up new lines of communication to help resolve differences. The second round of negotiation meetings may also benefit from the involvement of additional personnel, such as construction managers with specialty experience in the type of construction required for the project. [Colorado] DOT may consult with internal or consultant construction managers that have unique experience with the complexities of construction methods for a particular project and provide valuable insight into the Contractor's methods and means.

If a third CAP Proposal and subsequent negotiations are required the stakes become high for both [Colorado] DOT and the Contractor. Failure to reach an agreement will result in significant losses to both parties. The Contractor risks losing a contract for a project that they have helped direct and for which they have significant knowledge of the project details. [Colorado] DOT risks losing the Contractor's expertise and the risk management strategies incorporated into the CM-GC delivery method. For these reasons, negotiations for the third CAP Proposal should be elevated to include the highest level of management, including executive level personnel from [Colorado] DOT and the Contractor.

At this stage, negotiations can become very intense and it may be helpful to refer back to the partnering workshop held at the beginning of the Preconstruction Phase. The partnering session should have identified an escalation ladder to help resolve conflicts and can remind all parties of the mutual goals that were established for the project. A second partnering session can also be conducted to bring the team back together.

Revealing Pricing Differences

Typically, the ICE estimate and amount of any pricing differences are not revealed to the Contractor, however, the [Colorado] DOT Project Manager has the flexibility to reveal pricing if it helps to advance

(continued on next page)

negotiations. For example, if a particular bid item has a significant difference, revealing the pricing information may provide the Contractor an opportunity to explain the difference. It may be discovered that the ICE's pricing assumptions are inaccurate and that the ICE should seek out additional experts to refine the estimate. Conversely, it may convince the Contractor to reevaluate its methods or revisit its pricing assumptions.

Failure to Reach an Agreement

The Contractor will have the opportunity to prepare and submit up to three CAP Proposals. After the third and final attempt at a CAP negotiation, [Colorado] DOT reserves the right to prepare the plans, specifications, and estimate package for advertisement as a traditional bid. The Region will prepare a letter, on behalf of Region management, to the FHWA Operations Engineer (regardless of oversight) and [Colorado] DOT Chief Engineer explaining that an agreement could not be reached with the CM-GC Services Contractor and recommending that the project proceed as a design–bid–build. The CM-GC Services Contractor will not be allowed to bid.

References

Arizona Department of Transportation. *ADOT Construction Manager at Risk (CMAR), Process Guide,* 2nd Edition. September 2014. https://www.azdot.gov/business/standards-and-guidelines/guidelines. Accessed September 26, 2017.

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC).* 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

24 Independent Cost Estimator

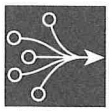
The independent cost estimator is an independent consultant hired by the owner to prepare a project cost estimate. The independent cost estimator's cost estimate is considered a blind estimate because it is not revealed to the other estimators. Tools related to the independent cost estimator include the cost-comparison spreadsheet, cost-modeling approach, the OPCC process, and the CM-GC bid validation.

What Is It?

The independent cost estimator prepares a production-based cost estimate using a process similar to the contractor's approach for preparing an estimate (AASHTO 2013). This production-based estimate contrasts with typical agency estimates of probable costs that are based on historical bid data. The independent cost estimator typically meets with the project team at a cost model review meeting to develop cost model assumptions used by all parties preparing estimates. The independent cost estimator also typically attends risk management meetings to determine how key project risks impact project costs.

Why Use It?

The independent cost estimator provides the agency with independent estimates developed using the same cost-development procedures as the contractor to help ensure that the CM-GC's estimate is competitive. The agency can also use the independent cost estimator estimate to verify and uncover discrepancies in estimating assumptions and as a basis for negotiating the CAP or GMP. Potential benefits include cost savings to the agency and early knowledge of costs.


ALIGNMENT


PRECONSTRUCTION QUALITY

Similar to the CM-GC bid validation, the independent cost estimator addresses the Alignment Strategy and the Preconstruction Services Quality Strategy. This tool ensures that the agency and CM-GC are aligned with regard to the cost details of the project. This tool is also the culmination of the preconstruction phase, in which the CM-GC provides input on the design and develops cost and schedule estimates. The CM-GC can develop a fair price proposal based on these factors.

When to Use It?

An agency employs an independent cost estimator when it wants an estimate to verify the competitiveness of the CM-GC's cost estimate. The independent cost estimator can be contracted at the same time the CM-GC is contracted. The independent cost estimator can participate in early project meetings to help develop estimating assumptions. The independent cost estimator can prepare cost estimates each time the CM-GC prepares an estimate for a project submittal.

An independent cost estimator is recommended for moderate to complex projects that are more than $10 million in value (Table A.27). For smaller projects that are not complex, the project team can consider using this tool on a case-by-case basis, depending on whether the likely benefits will justify the added cost.

How to Use It?

The independent cost estimator generally participates in:

- Cost model review meetings,
- Risk management review meetings, and
- Cost estimate review meetings.

Table A.27. Recommended uses for an independent cost estimator.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
24 Independent Cost Estimator			✓			◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

The agency compares the independent cost estimator estimate with the CM-GC estimate and uses that information to discuss and negotiate the estimate with the CM-GC firm. The agency may have the independent cost estimator participate in cost estimate review meetings, where estimate differences are discussed and assumptions and quantities are reviewed with the aim of closing the gap between the estimates.

Example 1

Colorado Department of Transportation *CM/GC Manual*

The Colorado DOT *CM-GC Manual* describes the independent cost estimator and the independent cost estimator procurement process in the following excerpts:

> **Procuring an ICE for a CM/GC Project**
>
> Hiring a qualified ICE is a key component in the CM-GC process and is critical to the development of the project CAP and understanding of the Contractor's means and methods. [Colorado] DOT maintains a Non-Project Specific (NPS) Contract with an ICE Consultant.
>
> Typical consultant task orders are generated by the project manager (PM) and processed through the Region Business Office. ICE consultant contracts are managed through the Innovative Contracting Program at headquarters and processed using procurement services at headquarters.
>
> To initiate an ICE consultant contract, the PM will contact the Innovative Contracting Program Manager to discuss available ICE consultants under contract and request the outline agreement contract or number for the ICE to be used for the project. The Innovative Program Manager will provide the amount remaining and the expiration date for that contract. The PM will initiate contact with the prospective ICE consultant to work through hours and amount of the services needed for the task order. The rule of thumb for the contract amount is between 0.4–0.5% of the construction budget. However, the PM should substantiate this using [the] projected number of meetings, Owner Controlled Insurance Program (OCIP), and [the] CAP negotiation meetings necessary. Also consider if there is specialized project work, such as tunneling, bridge moves, etc., requiring a cost estimator that is familiar with that type of work.

ICE Estimate

[Colorado] DOT contracts with an ICE who develops an Independent Cost Estimate for comparison with each of the Contractor's OPCC submittals. The ICE Estimate is a production-based estimate that uses the same assumptions agreed to and documented in the Cost Model. This estimate serves as the official [Colorado] DOT Engineer's Estimate once accepted by [Colorado] DOT Engineering Estimate and Marketing Analysis (EEMA).

CAP Proposal and Negotiations: Revealing Pricing Differences

Typically, the ICE Estimate and amount of any pricing differences are not revealed to the Contractor; however, the [Colorado] DOT Project Manager has the flexibility to reveal pricing if it helps to advance negotiations. For example, if a particular bid item has a significant difference, revealing the pricing information may provide the Contractor an opportunity to explain the difference. It may be discovered that the ICE's pricing assumptions are inaccurate and that the ICE should seek out additional experts to refine the estimate. Conversely, it may convince the Contractor to reevaluate its methods or revisit its pricing assumptions.

Example 2

Arizona Department of Transportation *Construction Manager at Risk (CMAR) Process Guide*

In this manual, Arizona DOT describes the responsibilities of the independent cost estimator or independent reviewer.

Role of the Independent Cost Estimator

The primary responsibility of the Independent Reviewer is to engage in a constructive dialog with the Department, the Designer and the CMAR Contractor during the Preconstruction Phase of the project. The Independent Reviewer will develop a detailed independent cost estimate (ICE) for the contract items and also review the CMAR Contractor's schedule and Cost Model. The Independent Reviewer's analysis will red-flag cost and/or schedule variances, validate the CMAR Contractor's price structure, and assist in negotiation of the Guaranteed Maximum Price (GMP).

The secondary role of the Independent Reviewer is to provide technical support during the development of the project plans, as follows:

- Attend task meetings as required,
- Provide guidance on reasonable fees and overhead, [and]
- Document lessons learned.

References

AASHTO. *Practical Guide to Cost Estimating*, 1st Edition, Washington, D.C., 2013.

Arizona Department of Transportation. *ADOT Construction Manager at Risk (CMAR), Process Guide*, 2nd Edition. September 2014. https://www.azdot.gov/business/standards-and-guidelines/guidelines. Accessed September 26, 2017.

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC)*. 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

25 Cost-Savings Matrix

This tool is a table listing the innovations or cost-saving measures developed by the project team to enhance the project in a variety of ways, such as cost and schedule.

What Is It?

A cost–savings matrix is a table for tracking innovative ideas, their impact on the project, who is responsible, and the status of the innovation. Innovative ideas may be novel approaches or simply efficient ways to reach project goals. Impacts to the project may be cost savings, time savings, improved safety, quality, access, and so on. A responsible party for follow-up is designated to research the innovation and its impacts. The information about the innovation is reviewed by the team so that a decision can be made whether to accept and implement the innovation.

Why Use It?

The cost–savings matrix is a tool that reminds teams to think innovatively. The cost–savings matrix provides a single place to document innovative ideas that are under consideration and provides structure for investigating innovative ideas and tracking the status of each idea as it is explored. The cost–savings matrix provides a document that the agency can use to assess whether the CM-GC delivery method brought innovation to the project and what benefits accrued to the project. Innovations can be lessons learned for an agency, so the cost–savings matrix also provides documentation for lessons learned that can be applied to future projects.

The potential benefits of a cost–savings matrix include cost savings, schedule acceleration, and construction input in design to encourage constructability, innovation, and risk mitigation.

The cost–savings matrix addresses the Alignment Strategy, Scope Strategy, and Preconstruction Services Quality Strategy. Goals can be clarified and productive relationships built as a team explores innovations together. Scope is constantly referred to as options are analyzed. Identifying and researching innovative opportunities keeps the contractor engaged throughout the design phase.

When to Use It?

The cost–savings matrix is used during the preconstruction phase (Table A.28). Since the contractor is involved during the design phase and sharing preconstruction input, most innovation will be raised during design.

How to Use It?

The cost–savings matrix can be created in a spreadsheet. The cost–savings matrix is a topic of discussion that can be placed on the agenda for project meetings. All team members must be open to innovation for this tool to be accepted and used effectively by the team.

Synthesis of Examples

The primary purpose of an innovation matrix is to document the innovation, its estimated cost, schedule, or other benefits. If the innovation is recommended, the matrix can also document

Table A.28. Recommended uses for a cost–savings matrix.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
25 Cost–Savings Matrix			✓			◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

the plan to implement it on a project. Agencies usually develop a standard table to document this information to help facilitate the decision about whether to implement the innovation. While the format of an innovation matrix can vary, the typical information on the matrix includes the following:

- Description of the innovation,
- Identification of which area of the project would be impacted (e.g., phase and work type),
- Estimated cost savings,
- Estimated schedule savings,
- Estimated other types of benefits (e.g., reduction in risk),
- Costs or changes in other areas (if the innovation were implemented),
- Recommendation, and
- Action items and responsible parties (if the innovation is recommended to be implemented).

Example 1

I-70 Vail Underpass Project, Colorado Department of Transportation

For this project, the contractor developed an innovation matrix and kept the value engineering (VE) contributions updated. The following are a few examples from the innovation matrix:

Innovation Identification				Value Added			Action Items					
VE No.	VE Name	Date Initiated	Description	Estimated Cost Savings	Schedule Savings (Shifts)	Additional Value Added	Current Status	Action Required By	Action Required	Date Required	Final Decision	Final Decision Date
	Phasing		Utilize head-to-head traffic to maintain 100% mobility	$833,000	TBD (2 months anticipated)	Minimize risk associated with utility relocation by providing flexibility	Complete	Contractor	Estimate Detour paving requirements and cost	12/9/2014	Phasing with one-way traffic developed and accepted by project team and stakeholders	12/19/2014
								Designer	Determine availability of North Frontage Road detour on Lion Ridge Loop			
	Refine phasing		Ongoing refinement to minimize detour lengths and maintain efficiencies in construction	TBD	0 over previous phasing	Smaller impacts to adjacent Colorado DOT right of way and other properties	Under review	Designer	Design team updating and to be included in Final Office Review plan set	Final Office Review Plans	na	na
	Raise I-70 profile		Raise I-70 profile	$300,000	Undetermined but less excavation would reduce duration	Additional value potential in less impacts to utilities and smoother drainage issues	Not incorporated	Contractor	Provide estimate for replacement of I-70	9/30/2014	Determined not to incorporate due to stakeholder feedback and additional design and environmental clearance impacts	11/3/2014
								Designer	Determine adjustments to South Frontage Road alignment (savings in excavation quantity)	9/30/2014		

Note: TBD = to be determined; na = not applicable.

Example 2

Winona Bridge Project, Minnesota Department of Transportation

Minnesota DOT calls their innovation matrix a Cost and Schedule Savings Matrix. The individual concepts are summarized in a Cost and Schedule Savings Summary Log. On this project, the team not only used a Cost and Schedule Savings Matrix but communicated the benefits of those innovations in an infographic, or project newsletter. Also, please see 19 Public Announcements.

	Cost + Schedule Savings Matrix					ID #	
						Champion	
						Date	
Discipline	☐ Roadway	☐ Structures	☐ Drainage	☐ Utilities	☐ Environmental		**Innovation?**
Area of Improvement	☐ Constructability ☐ General Conditions	☐ Phasing ☐ Risk Reduction	☐ Materials ☐ Other	☐ Standard Spec	☐ Design Alternative		☐ Yes ☐ No
Proposed Concept							
Description of Proposed Concept							
Impacts Anticipated From Due to Implementing Proposed Concept	**Impacts to Construction Scope**	**Impacts to Design Scope**	**Other Impacts to MnDOT (Utility, Right-of-Way, Environmental)**		**Impacts to Project Risks**		
Cost Impact	$0	$0	$0		$0		
Schedule Impact	0	0	0		0		
Total Impact to Schedule and Costs				**Cost:**	$0		
				Schedule:	0		
Recommendation							
Follow-up							
Final Resolution							
Date Closed				**Implemented?**		☐ Yes	☐ No

Cost and schedule savings matrix.

Construction manager–general contractor cost savings and innovations.

Work Package	Innovation	Time Savings	Cost Savings	Notes	Infographic Available
1	Preliminary Design Consultant Scope of Work		$1,000,000		Yes
1	42" Cast-in-Place Piling		$638,000		Yes
1–6	Environmental Management		$250,000	Typically, Minnesota DOT and contractor have environmental managers.	Yes
1–4	No Construction Claims		$5,500,000	Design–Bid–Build post-letting goal is 7%, and we are under the letting amounts of $79 million.	Yes
2	Used Concrete Barrier for Sheeting Tiebacks		$100,000		Yes
2	Clarification Process During Bidding		$225,000		Yes

References

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC).* 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

26 Opinion of Probable Construction Cost Process

This tool is an iterative process for monitoring the expected construction cost during development of the design packages. Tools related to the OPCC process include the independent cost estimator, the cost-comparison spreadsheet, the cost-modeling approach, and the CM-GC bid validation.

What Is It?

The OPCC process is a procedure used to validate the CM-GC's construction price at key milestones during the project design process. It is an iterative process, performed by the CM-GC as a preconstruction service through approximately 90 percent of the design. The agency compares the CM-GC's OPCC or construction estimate for the work with the cost estimate prepared by the independent cost estimator. The price comparison is performed using a cost–comparison spreadsheet.

Why Use It?

The OPCC process supports agency validation of the interim estimates provided by the CM-GC and provides the agency with an early indication for project cost. The OPCC process facilitates review of the assumptions used to develop the estimate. Early detection of pricing variations provides time for the agency and the CM-GC to come to agreement on assumptions and make changes to the design or scope in order to keep the total project cost within budget. The OPCC process is intended to minimize differences between the agency and the CM-GC final cost estimates. The OPCC process serves to clarify differences between CM-GC and agency estimates and supports resolution of those differences with minimal or minor design changes.

Potential benefits of the OPCC include cost savings and early knowledge of costs. In D-B-B, estimates during design typically rely on historical costs. OPCC process provides an opportunity for the agency to obtain a current, built-up cost based on actual costs of materials, labor, equipment, overhead, and profit.

The OPCC process addresses the Alignment Strategy, the Scope Strategy, and the Preconstruction Services Quality Strategy. The OPCC process helps to align costs with the budget and scope. The iterative nature of the process keeps the contractor engaged throughout the design phase.

When to Use It?

The OPCC process is used during the preconstruction phase (Table A.29).

How to Use It?

The agency can use an independent cost estimator or its own estimating staff to prepare a bottom-up estimate similar to how contractors develop cost estimates. Some agencies do an independent cost estimator estimate as well as an agency estimate. Prior to preparing the estimates, a basic cost model and assumptions related to pricing and construction methods are shared among the CM-GC, the independent cost estimator, and the agency estimators. There may be some discussion concerning assumptions before they are accepted. OPCCs are prepared with key submittals. The design percentage complete is dependent on the specific project but

Table A.29. Recommended uses for opinion of probable construction cost process.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	Construction	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
26 Opinion of Probable Construction Cost Process			✓			◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

may include the 30 percent, 60 percent, and 90 percent stages. At each stage, the contractor submits a nonbinding OPCC estimate. The OPCC estimate is considered a good-faith estimate of construction costs by the CM-GC, and it is assumed that the prices for items will not change significantly between milestones. The agency uses a cost-comparison spreadsheet to compare the independent cost estimator estimate–agency estimate with the CM-GC OPCC. Percentage deviations above or below are noted by the agency. The agency project management team is typically the only entity that views the cost-comparison spreadsheet. Each estimating group is blind to the estimates prepared by the others. The agency may or may not share percentage band deviations (i.e., above or below 10 percent) with the CM-GC, the independent cost estimator, and/or the agency's estimator. Possible reasons for cost variations are discussed, and assumptions are clarified or revised.

Synthesis of Examples

Agencies that use the OPCC process use a well-documented method to ensure the process is consistently utilized across their CM-GC projects. Important elements that should be addressed in the OPCC process include the following:

- Establish when OPCC estimates are to be developed for the project.
- Determine level of detail required of the OPCC with regards to
  - Labor costs,
  - Material costs,
  - Equipment costs,
  - Bonds,
  - General conditions, and
  - Indirect costs.
- Perform activities that produce required input in the development of the OPCC (e.g., workshops, input from design consultant, and input from agency groups).

The agency should also outline a process describing how to identify which variances between the OPCC and the independent cost estimator will warrant reconciliation.

Example 1

Winona Bridge Project, Minnesota Department of Transportation

Minnesota DOT used their OPCC process to establish interim cost estimates. This effort helped the project team clearly state assumptions and adjust the design to meet budget constraints better. A detailed description of Minnesota DOT's draft OPCC process document follows. This process is based on input from FHWA, the Minnesota DOT, the Minnesota Association of General Contractors, and the Minnesota American Council of Engineering Companies.

Task 1: Prepare OPCC Plan Package

The Design Engineer prepares and distributes an OPCC Plan Package for each pricing milestone. Each OPCC plan package should include plans, quantity take-offs, measurement/payment definitions, and any specifications appropriate for the level of design. Plans should be labeled as "OPCC Plan Package #" where # corresponds with the pricing milestone iteration. Plans should be prepared at typical design review milestones used in a design–bid–build (D-B-B) process, but can be adjusted in CM-GC depending on the complexity of the project. Also in CM-GC, the plans prepared by the design engineer may be customized based on requests from the CM-GC Contractor to help them prepare their OPCC. No formal Central Office (CO) review of OPCC plans is required.

Task 2: Hold Design Review Workshop

Hold a Design Review Workshop with the project team, where the review team consists of the [Minnesota] DOT's project manager and project staff, design engineer, CM-GC Contractor, and ICE. The CO Estimating Office staff (and any of their designees) attends these meetings at their discretion as an observer. During these workshops, each party reviews the plans and quantities with the following objectives: (1) allow all parties to understand the work that is being estimated, (2) allow the CM-GC Contractor to provide feedback on the constructability of the plans, (3) discuss assumptions on means and method regarding how the project will be bid, (4) define and agree upon what is included in a bid item, and (5) allow all parties to identify any errors, omissions, ambiguities, or other items that need to be corrected in the OPCC plans.

Task 3: Hold Risk Workshop

Hold a formal risk workshop that includes the following parties: Owner, design engineer, CM-GC Contractor, and ICE. The CO and Bridge Estimating Office staff attend these meetings at their discretion as an observer. During this meeting, the project manager and CM-GC Contractor agree on how risks and contingencies are quantified and assigned. The ICE participates in this discussion to stay informed and understand risk and contingency assignment. Adjustments to plans and quantities may be needed based on discussion at the risk workshop. During early risk workshops, a significant amount of time will be spent identifying risks and assigning time and cost impacts for each risk. During later workshops, the focus of the meeting will be to identify any new risks that have been encountered and update the risk model for risks that have been retired or where the time and cost impact has been reduced.

Task 4: Build Cost Model/Document Assumptions

Successful price justification in CM-GC relies on thoroughly documenting the assumptions that were used by the CM-GC Contractor to price the work. Documentation is maintained to capture a history of how this changes at each pricing milestone. To this end, the CM-GC Contractor will be expected to be open and transparent about how the work is bid, and will prepare or update a cost model with each OPCC that clarifies the means, methods, assumptions, and risks that were used to price the work for

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each OPCC. A narrative summarizing the cost model is provided to [Minnesota] DOT's project manager by the CM-GC Contractor to summarize the key pricing assumptions for each OPCC. The cost model narrative includes such things as: type of equipment proposed to perform the work, assumed production rates, crew sizes, shifts per day, hours per shift, risk assumptions, assignment of risks, assumed weather delays, and supporting subcontractor quotes. Pricing specific data that is considered proprietary by the CM-GC Contractor should be omitted from the cost model narrative that is submitted to [Minnesota] DOT in writing but is still expected to be available to [Minnesota] DOT for "over-the-shoulder" reviews during price reconciliation meetings.

Task 5: Preparation of OPCC and Estimates

Based on input from the design and risk workshops, the design engineer updates the OPCC plans (if necessary) and the estimates are prepared for the work to be performed for each pricing milestone plans. Estimates prepared by the ICE and CM-GC Contractor should be a "bottom up", contractor style estimate prepared by using typical contractor-style estimating software. Although the estimates are prepared using a "bottom up" approach, costs provided to [Minnesota] DOT should be rolled up into unit costs or lump sum items typical of those used on [Minnesota] DOT D-B-B and D-B projects.

A) Contractor OPCC: The CM-GC Contractor prepares their price for the work, or OPCC.
B) Independent Cost Estimate: The ICE prepares their estimate for the work at each pricing milestone. By statute, [Minnesota] DOT is required to use an ICE to perform an independent cost estimate for the work. The ICE reports to [Minnesota] DOT's Office of Program Management and receives oversight from this office. The CO Estimating Office and the Project Manager do not direct or manage the ICE in order to maintain the independence of the ICE.
C) CO Estimating Office Review Estimate: At their discretion, the CO Estimating Office prepares a Review Estimate. The CO Estimating Office provides a Review Estimate at the 90% pricing milestone preceding the final Guaranteed Maximum Price (GMP) bid to help identify any major discrepancies between the bidding assumptions between the ICE and CO Estimating Office. At earlier OPCC reviews, the CO Estimating Office may elect (at their discretion) to review the estimates and the CM-GC Contractor's OPCC and offer opinions about the estimates and the OPCC. The CO Estimating Office performs their estimates and reviews themselves. By statute (Minnesota Statute 2012, Subdivision 1) any Estimate prepared by the "department employees" is non-public and is not available to the public from the time of final design until the project is awarded. The project team will be allowed to share the bidding assumptions, cost model, and risk register with the CO Estimating Office, but the project team is strictly prohibited from viewing the Review Estimate produced by the CO Estimating Office or attempting to influence or see the Review Estimate. The CO Estimating Office is allowed to see any of the estimates at their discretion.
D) Owner's Estimate: Because the ICE's estimate is "blind" or hidden from the project team during pricing milestones, the project manager (at their discretion) may elect to perform an Owner's Estimate so that the project team can see estimated costs. The Owner's Estimate is prepared at each milestone by the design consultant or another qualified consultant under the direction of the Project Manager. Preparation of an Owner's Estimate is optional at the discretion of the Project Manager. An Owner's Estimate can be helpful when trying to reconcile pricing differences, but it does add additional preconstruction costs to the project. It may be more appropriate to perform an Owner's Estimate for large, complex CM-GC projects. Below are some potential advantages to weigh when considering the use of an Owner's Estimate on a project:
   - It provides another perspective that can be used in reconciliation discussions to help resolve disagreement.
   - It provides another "set of eyes" on more efficient ways to bid the work.
   - It can be fully examined by the Project Manager. This gives the Project Manager the opportunity to understand how the work is bid, how risk and contingency gets assigned, and how production and labor costs get rolled up into unit prices.

Task 6: Submit Estimates and OPCC

The ICE and the CM-GC Contractor submit their estimate/OPCC for the work directly to the [Minnesota] DOT's Office of Project Management. OPCCs and estimates should NOT be submitted directly to the project team or the project manager. The Owner's Estimate is submitted directly to [Minnesota] DOT's project manager.

Task 7: Preparation of Variance Report

During each interim pricing milestone, the CM-GC Contractor's estimate will be compared with the ICE. The [Minnesota] DOT Office of Project Management performs a variance analysis of the OPCC using 10% variance as a benchmark. They identify for the project team all bid items where variance between the ICE and the CM-GC Contractor's OPCC is greater than 10%. They will also inform the project team if the overall OPCC is within 10% of the ICE.

Task 8: Pricing Reconciliation Meeting (Price Validation Process)

The project team holds a pricing reconciliation meeting at each pricing milestones. During these meetings, the project manager and the CM-GC Contractor attempt reconcile pricing differences for every item identified as greater than 10% variance. The project manager may elect to ignore bid items that exceed 10% because they are considered insignificant to the overall cost of the project. The reconciliation process gives both the CM-GC Contractor and [Minnesota] DOT opportunities to understand each other's perspectives about pricing assumptions and risk assignment. The goal is to narrow pricing differences throughout the CM-GC preconstruction process, with the end goal of having the GMP bid within 10% of the ICE.

The ICE is present at the reconciliation meetings to hear the discussion and ask questions as needed to clarify. It is the Project Manager's responsibility to help ensure the ICE remains independent during reconciliation meetings. The CO Estimating Office can attend reconciliation meetings at their discretion.

Open Book Process: As part of the CM-GC open book estimating environment during the reconciliation process, [Minnesota] DOT may ask the CM-GC Contractor to "share" or review with them certain proprietary pricing data that clarify how the proposed pricing was derived in order to help reconcile differences between the ICE and the CM-GC Contractor's OPCC. All materials of this nature will be returned to the CM-GC Contractor at the end of each meeting and the data remains the sole property of the CM-GC Contractor unless the CM-GC Contractor agrees to release it to [Minnesota] DOT. **[Minnesota] DOT shall not retain a copy of any proprietary data, either electronic or in hard copy.** Proprietary pricing data is brought to the meetings but remains the property of the CM-GC Contractor. The CM-GC Contractor decides what, if any materials are retained in their records after the project is awarded. Review of proprietary data is used to help gain an understanding of the CM-GC Contractor's bidding assumptions and reconcile differences. Review of the CM-GC Contractor's pricing information is done in an "over the shoulder" review format and should not require leave-behind materials from the CM-GC Contractor. Price reconciliation meetings will be limited to key [Minnesota] DOT project management staff and estimating staff that are directly reconciling differences between the ICE and the CM-GC Contractor's OPCC estimate.

[Minnesota] DOT and the CM-GC Contractor may not be able to resolve all differences in pricing for certain bid items or for the overall price during OPCC reconciliation meetings. [Minnesota] DOT's project manager and the CM/GC Contractor will (a) decide to accept differences, move forward with design, and attempt to reconcile difference during later OPCCs, or (b) agree that reconciliation is not possible and terminate the professional services contract to allow [Minnesota] DOT to procure the construction of the

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project through some other method. If there are multiple work packages or contracts, the CM-GC Contractor is allowed to continue work on any contracts that were previously awarded.

Task 9: Adjust Cost Model and Schedule & Resubmit Pricing

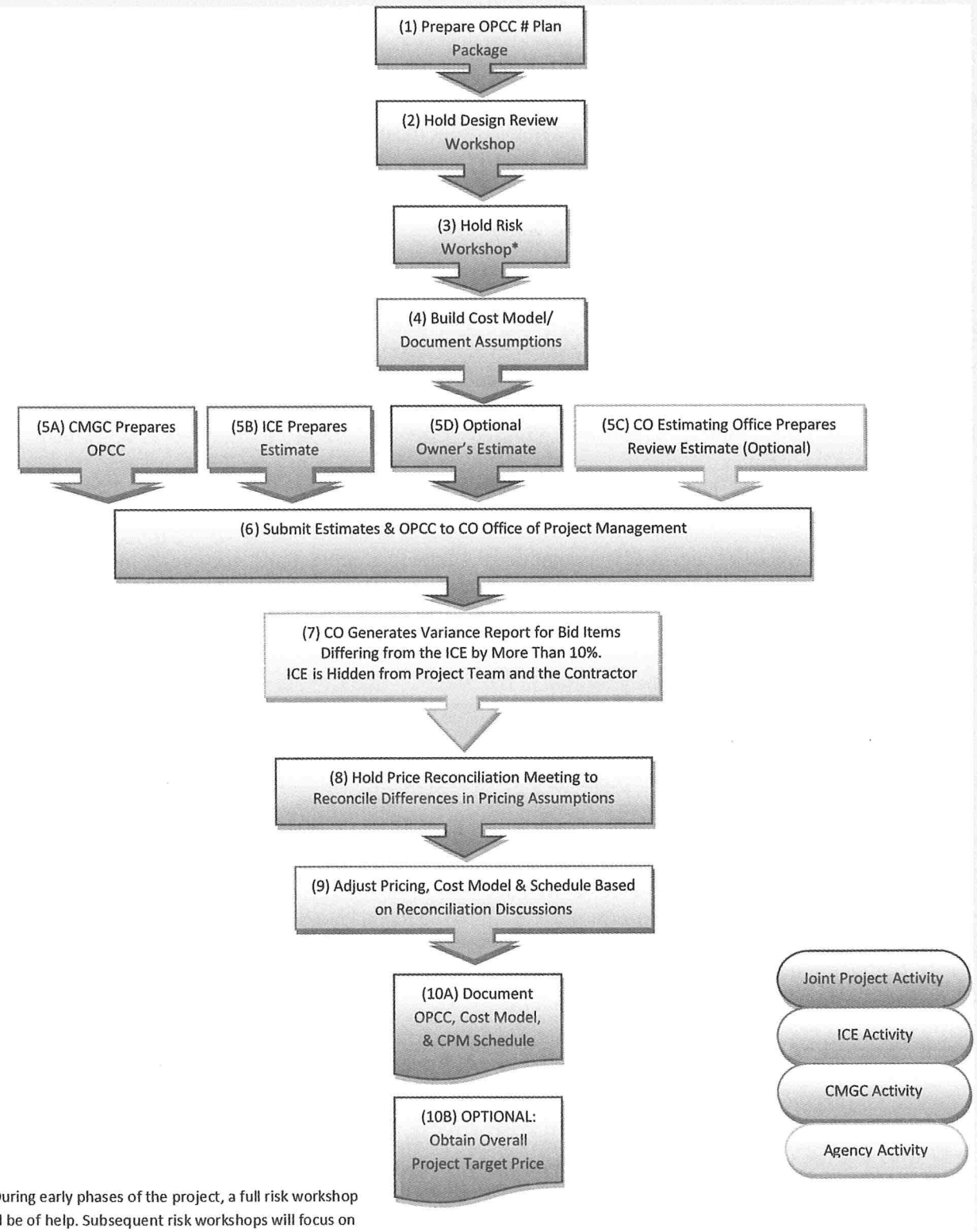
The project manager and the CM-GC Contractor agree upon changes to the bidding assumptions that affect pricing. Adjustments are made to the cost model and the schedule to reflect these changes. The cost model narrative is revised by the CM-GC Contractor and resubmitted to the project manager and documented in the project file. During the reconciliation process, the ICE may believe it is necessary to adjust their estimate to match agreed upon construction cost model.

Task 10: Document OPCC, Cost Model and Schedule

[Minnesota] DOT documents the OPCC, the cost model, and the critical path method (CPM) schedule in the project file. The [Minnesota] DOT Office of Project Management retains a copy of the OPCC and ICE. The project manager retains a copy of the OPCC Variance Report, the cost model narrative, and the CPM schedule for each milestone.

Projects with Severable Work Packages: If the project is considering separating the work into severable work packages, each with their own contract, the Project Manager should consider obtaining an Overall Project Target Price (OTP) from the CM-GC Contractor at some point in the OPCC process to demonstrate that all combined work packages will fit within the overall project budget. An OTP can be provided along with a work package's OPCC, or it can be provided when later when the guaranteed maximum price bid is submitted by the CM-GC Contractor.

Overall Project Target Price (OTP): The OTP is a non-binding, good-faith estimate of construction costs (like an OPCC) required to complete all work packages on a project. It is used by [Minnesota] DOT to verify that the overall construction scope can be completed within the available project budget. An OTP is based on the assumptions and risks that are known at the time the estimated costs are submitted to [Minnesota] DOT. The CM-GC Contractor's OTP is supported by a cost model and narrative similar to OPCCs. Although an OTP is a good faith estimate, [Minnesota] DOT assumes that pricing in the OTP will not vary dramatically without a documentable change in bidding assumptions that affects pricing.



* During early phases of the project, a full risk workshop will be of help. Subsequent risk workshops will focus on updating the risk model only based on any changes that have occurred between pricing milestones.

CM-GC interim pricing (OPCC) milestone process (Source: Minnesota Department of Transportation).

Example 2

Colorado Department of Transportation *CM/GC Manual*

The Colorado DOT CM-GC manuals explain that cost-estimating guidelines and assumptions are agreed to in advance. Cost estimates are required to be in detail in order to support development of budgets, schedules, specifications, and risk pools (see 27 Risk Pools). The OPCC process is described in the Colorado DOT *CM/GC Manual* excerpt that follows:

> **3.6.3 Opinion of Probable Construction Cost Submittals**
>
> The Contractor is responsible for preparing an Opinion of Probable Construction Cost (OPCC) at each agreed-to pricing milestone. Each OPCC is independently prepared but in coordination with the Design Consultant, [Colorado] DOT, and the ICE. Estimates must be based on quantitative takeoffs whenever possible and must be supported in sufficient depth and organization to be used in preparing budgets, bid schedules, Specifications, and Risk Pools. The specific cost coding structure, estimating guidelines, assumptions, and contents of the cost estimates are mutually agreed to by the Contractor, [Colorado] DOT, and the ICE prior to development of the first cost estimate to assure that estimates developed by all parties can be compared and reconciled. Each OPCC is produced in an open-book process through the Preconstruction Phase of the Project so that [Colorado] DOT and the ICE can make accurate assumptions, calculate prices, and determine the amount of risk in the project.
>
> When preparing any OPCC and in development of the Schedule of Bid Items, documents must include
>
> - The cost of all labor, materials, equipment, bond premiums, and actual costs of procurement or construction that the Contractor will use for the duration of such Long Lead-Time Procurement (LLTP) Phase or Construction Phase to complete the Work;
> - The General Conditions to be incorporated in the Work;
> - All indirect costs for review and approval by Colorado DOT; [and]
> - The Subcontracting Plan.
>
> For each OPCC, the Contractor must acquire multiple quotes from potential Subcontractors and Suppliers. This information is shared in the open Cost Model and the Contractor allows potential Suppliers and Subcontractors to share their information, quotes, and product data with the ICE, Colorado DOT, and the Design Consultant. The Contractor must also submit a Material Sourcing Plan, a written plan that details how the Contractor intends to handle bids from material vendors for any LLTP Construction Agree upon Price (CAP) or Construction CAP proposals. The Material Sourcing Plan is started during the 30% design phase and is updated with each OPCC. The Material Sourcing Plan, when fully developed, also is included in the final CAP Proposal package.

References

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC).* 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

Minnesota Department of Transportation. *Draft CM/GC Interim Pricing (OPCC) Milestone Process,* Draft. 2013. www.dot.state.mn.us/const/tools/docs/cmgc-cost-estimating-process.docx. Accessed August 24, 2017.

27 Risk Pools

A risk pool is a fund set aside to cover risks that may occur on a project.

What Is It?

Risk pools are project funds established as agency risk pools or shared risk pools. They are different than contractor risk for items such as equipment and labor availability, which is included in the price proposal. Risk pools are also different than cost overruns or scope changes, which are handled through change orders to the contract.

Why Use It?

Risk pools are the basis for establishing planned force accounts in the construction contract that can pay for risks that materialize during construction. The responsibility for risk is placed in the hands of the party most able to manage the risk. Contractors typically add a contingency on activities that carry unusual risks. It encourages the project team to avoid, mitigate, and eliminate risk, thus keeping project costs lower. It also keeps project costs lower by avoiding contractor contingencies in price proposals to cover risks that the contractor is not best able to manage. Risk pools developed during design are converted to planned force accounts in the construction contract. The agency force accounts and shared force accounts serve as mechanisms for paying for work associated with risks that occur during construction. Risk pools are a mechanism for quantifying risk and assigning risk. Risk pools provide a source of funds to pay for risks that occur without having to develop a change order to the contract.

The potential benefits from risk pools include cost savings and shared risk allocation.

Risk pools address Alignment Strategy, Preconstruction Services Quality Strategy, and Construction Efficiency Strategy. Discussing risks promotes productive relationships associated with alignment. Allocating risk establishes responsibility, which is associated with scope. Minimizing contingency pricing promotes construction efficiency.

When to Use It?

Risk pools are developed during preconstruction and can be used during construction (Table A.30).

Table A.30. Recommended uses for risk pools.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	**Preconstruction**	**Construction**	Closeout	Noncomplex	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
27 Risk Pools			✓	✓		○	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

The project team identifies, analyzes, and assigns risks to the party best able to manage those risks. Risk registers and risk management plans are other tools used to manage risk. Throughout the project, the project team regularly reviews risks and seeks ways to avoid, minimize, or eliminate risk. Construction risks may be assigned to the agency, the contractor, or shared between the two. The potential cost of dealing with a risk—if it materializes—is estimated, and funds are set aside in risk pools to cover potential risks. The agency checks the contractor's pricing for all risk items with an estimate from an independent cost estimator. A contractor's internal risk—such as labor and equipment availability—is not included in the risk pools. The risk pools developed during design are changed to planned force accounts for construction.

Synthesis of Examples

Agencies that implement risk pools should document the process for developing risk pools in the CM-GC manual or other guidance documents. Guidelines for developing risk pools typically address the following:

- Guidance about when work items should be considered as part of a risk pool versus other forms of risk management methods (e.g., contractor contingency),
- When a risk is covered exclusively in the agency's own risk pool and when a risk is covered in a shared risk pool,
- Process for estimating the dollar amount to be set aside in the risk pool(s),
- Guidance on how shared savings should be split between the agency and the CM-GC,
- Process for converting risk pools to force accounts, and
- Guidance for approving payment out of the risk pool.

Risk pools should be implemented in conjunction with risk analysis procedures.

Example 1

I-70 Vail Underpass Project, Colorado Department of Transportation

This project followed guidance from the Colorado DOT *CM/GC Manual* on how to develop risk pools. Some of the risks identified were impacts to paving due to early winter weather, difficult ground conditions for soil nail drilling, ground water in excavations, encountering boulders during excavation, and delays in utility relocations performed by others.

Allocate the Risk

Once a risk has been identified and quantified, it is assigned to either [Colorado] DOT or the Contractor. The goal is to assign the risk to the party who is best able to control the risk. Risks can be allocated solely to the Contractor or [Colorado] DOT, or they can be shared. Risk is accounted for in three ways: (1) risk that is allocated to the Contractor is included within the Contractor's bid items; (2) risk that is allocated to [Colorado] DOT is accounted for in the [Colorado] DOT Risk Pool; and (3) risk that is to be shared is accounted for in the Shared Risk Contingency Pool. Additionally, risk for minor overruns and Contract changes are addressed by a [Colorado] DOT Risk Pool similar to Design–Bid–Build (D-B-B) Force Accounts. Minor Contract Revisions (MCRs) for CM-GC projects can usually be significantly less than for traditional D-B-B as a result of the risk mitigation process and cost allocation to risk pools. The Contractor and

[Colorado] DOT develop risk pools for risks that need to be addressed through the [Colorado] DOT Risk Pool or Shared Risk Contingency Pool by following four steps:

1. The CM-GC Contractor submits drafts of the items, including estimates for those items, to be covered by Minor Contract Revisions (MCRs), Overruns, [Colorado] DOT Risk Pools, and Shared Risk Contingency Pools for [Colorado] DOT review and acceptance.
2. The CM-GC Contractor submits drafts of the definitions for Shared Risk Contingency Pools for [Colorado] DOT's review and acceptance.
3. The CM-GC submittals are reviewed by [Colorado] DOT, with technical input from the Design Consultant and cost validation from the Independent Cost Estimator (ICE).
4. Once accepted, [Colorado] DOT adds the items and definitions to the Risk Register as a Project Special Provision for team review, acceptance, and signing.

Monitor and Control the Risk

. . . During the Construction Phase, [Colorado] DOT and the Contractor monitor contingencies and the Risk Pools to ensure that the established Risk Pools are adequate for the actual realized project risks.

[Colorado] DOT Risk Pool

The [Colorado] DOT Project Manager should consider taking ownership of the risk if [Colorado] DOT has a better opportunity to manage the risk than the Contractor or if the risk is completely beyond the control of the Contractor (e.g., weather, changes in site conditions, [and so on]). The [Colorado] DOT Project Manager may also consider taking ownership of the risk if he or she believes the probability of the risk occurring is less than the Contractor's assessed probability. For example, a Contractor is including a high contingency in a bid item to cover the cost of potential weather delays that could increase the rental costs for a specialty piece of equipment. [Colorado] DOT may decide to take that risk and include this price within the [Colorado] DOT Risk Pool. If the weather delay occurs, [Colorado] DOT is responsible [for paying] the Contractor. However, if the weather delay does not occur, then [Colorado] DOT has saved the contingency cost without sharing the cost savings with the Contractor.

Shared Risk Contingency Pool

The Shared Risk Contingency Pool is often the best tool for managing project risks that have a high amount of uncertainty, along with a high likelihood of occurring, but still have the potential for the Contractor to control. Typically, these items are identified and proposed by the Contractor, who submits a plan to [Colorado] DOT for review and approval. The potential amount of the shared risk is defined in the Risk Register along with a payment specification (a Project Special Provision). If the risk is encountered during construction, the Contractor is paid per the agreed-to payment specification. However, if the entire estimated risk is not recognized, [Colorado] DOT and the Contractor share the savings as identified in the Risk Register. Typically, Shared Risk Contingency Pools are split equally, but the amounts could vary if either [Colorado] DOT or the Contractor is assuming more risk. Ultimately, this is part of the negotiation and how [Colorado] DOT plans to manage the risk. CM-GC Project Special Provisions are required to contractually define shared risks.

The motivation for using the Shared Contingency Risk Pool is that it provides an incentive for the Contractor to control risk and maintain good production methods during construction. Under D-B-B or D-B project delivery methods, the savings of unrealized risks are kept entirely by the Contractor. Shared Risk Pools allows [Colorado] DOT the ability to recover a share of the unrecognized risk and collaboratively assist with controlling the risk when possible. However, to ensure fair pricing, the ICE is heavily relied upon to review all unit item costs and total estimated costs associated with any Contractor-proposed shared risks. If the Contractor and [Colorado] DOT cannot agree to an appropriate shared risk item price

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or total amount of the pool, the [Colorado] DOT Project Manager may decide to accept the risk entirely into the [Colorado] DOT Risk Pool.

Establishing Dollar Amounts for the Risk Pools

There is no standard formula to establish the dollar amounts to include in the risk pools for identified risks. The [Colorado] DOT Project Manager must use some judgment and work collaboratively with the Contractor and the ICE to include sufficient funds to cover the likelihood of the risks occurring without overestimating the contingency such that it falsely limits the budget available for the project's intended scope of work.

To provide guidance to [Colorado] DOT Project Managers, one way of viewing a simplified approach to risk allocation is to review the probability that a risk may occur. Generally, if the probability of a risk occurring is high, the entire amount of the risk should be considered for the risk pool. If both [Colorado] DOT and the Contractor are in agreement that the probability of a risk is low, it is often accepted entirely by one of the parties or alternatively included in the risk pool with a reduced amount (relative to its probability of occurrence). Challenges occur, however, when [Colorado] DOT and the Contractor are not in agreement on the probability of the occurrence of the risk. An approach for the [Colorado] DOT Project Manager to consider is to accept the risk into the [Colorado] DOT Risk Pool when the Contractor considers the probability of the risk occurring to be higher than [Colorado] DOT's assessment. Otherwise, from [Colorado] DOT's perspective, for shared risks, the Contractor can receive additional compensation for avoiding risks that are unlikely to occur.

The Risk Matrix can be an effective tool to assist in these discussions and in establishing appropriate amounts to include in the risk pools. The risk matrix should show the probability of the risk occurring and the total maximum cost impact if the risk does occur. To establish the contingency, a weighted average or expected value of the risk is then obtained by multiplying the probability of the risk occurring by the cost impact.

Contractors that routinely deal with risk may have more detailed methods involving complex simulations or other risk management informational systems. In these circumstances, the [Colorado] DOT Project Manager must collaborate with the Contractor to understand the approach and methods used in the risk analysis.

Force Accounts for [Colorado] DOT Risk Pool and Shared Risk Contingency Pool

Once the project moves into the Construction Phase, the previously established [Colorado] DOT Risk Pool and Shared Contingency Risk Pool become planned Force Accounts.

Example 2

Arizona Department of Transportation *Construction Manager at Risk (CMAR) Process Guide*

The Arizona DOT *CMAR Process Guide* describes how to develop fixed, open, and provisional allowances to cover risk. If a contractor requests a change order for work, Arizona DOT considers whether the work could be considered unforeseen even with the contractor's early involvement in the design phase.

GMP (Guaranteed Maximum Price) Allowances

There is a risk associated with the CMAR Contractor establishing maximum prices (for example, where subterranean features cannot be determined in advance, or where alternatives have not been selected by the Department). The CMAR Contractor can propose guaranteed maximum price (GMP) allowances. The allowances establish the type and amount of risk the Department and CMAR Contractor have assumed in agreeing to the GMP. In addition, the Department (documented by written consent) and the CMAR Contractor will agree upon the type of allowance and the terms and conditions regarding use of the GMP allowance.

When establishing allowances, the CMAR Contractor must provide the Department adequate justification for the allowance. The allowance(s) will be used only for the work that the allowance was negotiated to cover. Each allowance is item specific. Allowance monies are not interchangeable and belong to the Department if not used.

There are three types of allowances:

- **Fixed Allowance:** A fixed allowance establishes the upper limit the Department will pay for the corresponding item of work. For example, if there is a fixed allowance for 1,000 linear feet of saw cutting, the Department will pay the CMAR Contractor up to 1,000 linear feet of saw cutting above the quantity designated in the GMP Item Schedule for saw cutting.
- **Open Allowance:** An open allowance designates that there is no upper quantity limit for the corresponding item of work. The Department will pay for all approved quantity increases for each corresponding item in excess of the GMP Item Schedule. For example, if there is an open allowance for geotextile and the Department directs the CMAR Contractor to place more geotextile than what is shown in the GMP Item Schedule, the Department will pay the CMAR Contractor for the full amount placed.
- **Provisional Allowance:** A provisional allowance is for alternative work. For example, the Department has not completed a Joint Project Administration (JPA) with a local government to replace [Arizona] DOT chain link right-of-way fence. The quantities are known. The decision hasn't been made whether chain link, wrought iron or block will be used. The Cost Model will include an item for chain link right-of-way fence but two provisional allowances are set up, one for each type of replacement. (Another method would be to use the Provisional Allowances as a premium per foot for the selected upgrade.)

References

Arizona Department of Transportation. *ADOT Construction Manager at Risk (CMAR), Process Guide*, 2nd Edition. September 2014. https://www.azdot.gov/business/standards-and-guidelines/guidelines. Accessed September 26, 2017.

Colorado Department of Transportation. *Innovative Contracting (Design–Build and CM/GC)*. 2015b. https://www.codot.gov/business/designsupport/innovative-contracting-and-design-build. Accessed July 31, 2017.

28 Contractor-Controlled Quality Control Testing

This tool allows contractors to perform their own QC testing.

What Is It?

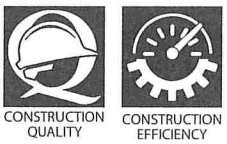
This tool removes restrictions placed on contractors that force them to retain an independent third party to perform their QC testing and inspection.

Why Use It?

Allowing contractors to perform QC functions using their own personnel simplifies scheduling, reduces costs, and may maintain equivalent levels of quality when compared to requiring a third party to perform the same functions. This is done by removing contract clauses demanding the use of independent laboratories or independent inspectors, and by inserting clauses that present contractors with the option to use their own personnel, provided certain conditions are met.

Allowing contractors to use their own directly employed personnel for QC testing and inspection reflects the direction that the industry is evolving: The more mature contractors are embracing QM as a key differentiator and are integrating QM into their core performance goals. This allows D-B contractors to be more cost effective, giving them a competitive advantage. Ultimately, the agency benefits from a lower price. For CM-GC contracts, agencies typically identify QC as a reimbursable direct cost, so the potential cost savings to the agency can be vetted during buyout of QC services. Larger projects may be able to support a contractor-provided, project-specific laboratory. However, smaller or more remote projects may benefit from using a local laboratory rather than to incur the cost of mobilizing a dedicated laboratory. Before a contractor can determine which approach is most viable, the agency must make the critical decision of whether the QC personnel are fully dedicated to QM, or if they have multiple job roles on the project. A variant of this model is for an agency to accept contractor sampling that is still sent to an independent laboratory for testing.

Potential benefits include cost savings and schedule savings. Cost savings can be realized by the elimination of the overhead and profit costs of independent laboratories, and cost savings and schedule savings can be gained from the contractor not having to wait for another party to perform testing.



Contractor-controlled quality control testing addresses the Construction Quality Strategy and the Construction Efficiency Strategy. Many construction projects have aggressive schedules; thus, having a QC person on site when that individual is needed is important to ensure quality during construction, as well as to assure the efficiency of the construction process.

When to Use It?

This tool is for D-B and for CM-GC, but the decision and timing is different for each. In fairness to all bidders, for D-B the agency should specify whatever options they will allow in the RFP. For CM-GC contracts, agencies typically identify QC as a reimbursable direct cost; the potential cost savings to the agency can be vetted during buyout of QC services.

Many agencies expressed hesitation in using this tool because they felt that it opened the opportunity for quality to be compromised. Agencies can thoughtfully develop QM

Table A.31. Recommended uses for contractor-controlled quality control testing.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	**Construction**	Closeout	**Noncomplex**	**Moderately Complex**	**Complex**	**< $10 million**	**$10 million–$50 million**	**> $50 million**
28 Contractor-Controlled Quality Control Testing				✓		●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

programs with process and checks on quality to assure that agency quality standards are being met with this tool.

This tool can be used with projects of all sizes and complexities (Table A.31).

How to Use It?

Contract clauses or standard specifications that require a contractor to retain a third-party independent laboratory to perform QC inspection and testing should be removed. A new clause must be added that establishes acceptable certification bodies or levels that inspectors and technicians directly employed by the contractor need to have.

Synthesis of Examples

For this tool to be successful, the agency should retain remedies to enforce contract provisions that the contractor uses only appropriately certified staff, keeps detailed records, and maintains open and frequent communication with the agency with regard to quality matters.

Example

Portland Transit Mall Revitalization, Tri-County Metropolitan Transportation District of Oregon (TriMet)

TriMet typically requires that contractors hire an outside, independently certified laboratory to perform QC testing. However, on TriMet's CM-GC South Corridor Light Rail Extension Project, the agency allowed the contractor to use directly employed inspectors and technicians to do the QC testing. TriMet's willingness to do this was based, in part, on the reputations for quality and integrity of both parties in the contracting joint venture and, in part, on TriMet's requirement that all inspectors and technicians be nationally certified to perform the needed inspections and testing. This decision saved the project money and streamlined the scheduling process by removing the inherent scheduling complications—which occur when dealing with an independent firm—without sacrificing quality (Molenaar et al. 2015).

References

California Department of Transportation. *Quality Control Manual for Hot Mix Asphalt for the Quality Control Quality Assurance Process.* June 2009. http://www.dot.ca.gov/hq/construc/publications/qcqaman1.pdf. Accessed February 18, 2018.

FHWA. *Contractor Quality Control Plans, Contractor Guidelines, and Example Quality Control Plan.* U.S. Department of Transportation, Washington, D.C. February 1998. https://flh.fhwa.dot.gov/resources/construction/documents/contractor-qc-plans.pdf. Accessed February 18, 2018.

FHWA. *Use of Contractor Test Results in Acceptance Decisions.* Technical Advisory T6120.03. n.d. https://flh.fhwa.dot.gov/resources/construction/documents/contractor-qc-plans.pdf. Accessed July 22, 2019.

Molenaar, K., D. D. Gransberg, and D. N. Sillars. *NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction*, Transportation Research Board of the National Academies, Washington, D.C., 2015.

29 Contractor Involvement in Establishing Quality Control Standards

This tool allows for changes to QC standards, which may result in more efficient QM programs.

What Is It?

This tool recognizes the unique nature of every construction project and the value that contractors can add to QM processes by streamlining sampling frequencies and requirements, where appropriate.

Why Use It?

The purpose of this tool is to customize and/or streamline QC on projects, where appropriate, without sacrificing overall quality and still meeting the goals of the project. This tool allows the agency to judiciously consider alterations to its traditional specifications and testing requirements. While an agency may typically apply traditional standards to every project, adopting the approach of this tool would mean an agency is willing to consider accepting some project-specific quality specifications instead of traditional standards when opportunities arise and the contractor clearly presents reasons to do so.

Potential benefits include cost savings and schedule acceleration when a more efficient and less costly process for achieving quality on a project is agreed upon.

Contractor involvement in establishing QC standards addresses the Construction Quality Strategy and the Construction Efficiency Strategy. Quality is maintained because appropriate quality standards are kept in place. Construction efficiency is maintained because unnecessary quality requirements are eliminated.

When to Use It?

Contractor-proposed alternate quality standards/specifications can be used on projects with prescriptive-based—not performance-based—quality specifications and is particularly useful in dealing with innovative or uncommon situations. The flexibility afforded by this tool is useful in instances where materials are used in a nontraditional manner.

This tool is recommended for medium to large projects that are moderate to complex (Table A.32). It can be considered for small, noncomplex projects if the work differs from standard construction.

How to Use It?

This tool is useful in a formal or an informal manner. Used formally, this tool involves the addition of contract language that allows the use of contractor-proposed alternatives to quality specifications, but only if sufficient justification is provided and documented. To use this tool informally, the agency and the contractor must establish a close working relationship in which both parties operate in good faith. It must also be recognized that the decision to approve or deny a project-specific specification ultimately resides with the agency. The agency should have agency discipline experts participate in the review of any deviations from QC standards. The agency project manager must be able to articulate to other agency personnel the benefit of the proposed changes and create an inclusive environment where discipline experts are actively engaged in the review process.

Table A.32. Recommended uses for contractor involvement in establishing quality control standards.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	**Construction**	Closeout	**Noncomplex**	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
29 Contractor Involvement in Establishing Quality Control Standards				✓		◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

Synthesis of Examples

QC standards should be in alignment with the intended function of the constructed facility. In the park path project example that follows, the agency allowed modified quality standards for an asphalt bike path. In another circumstance the agency may have required the standard specification if heavy maintenance vehicles or utility company vehicles accessed the path to maintain facilities along the path.

Example

Willamette River Bridge Project, Oregon Department of Transportation

Oregon DOT successfully used this tool on their Willamette River Bridge Project, where I-5 crosses the Willamette River. On that project, a CM-GC and Oregon DOT team customized quality standards and reduced the agency's QC costs based on several CM-GC–proposed alternatives to Oregon DOT's standard quality specifications.

In one case, hot-mixed asphaltic cement was to be used to pave the trails in the parks surrounding the project in order to meet the needs of the local park agencies. The typical Oregon DOT hot-mixed asphaltic cement specification required development and submittal of project-specific mix designs and optimum rolling procedures designed to provide the highest quality results on major paving jobs. In this case, those specifications would have added costs for very little return, as the demand on bike path pavement is so much less than the demand on interstate highway pavement, which the specifications were written for. The costs of the submittals and testing, when spread into the very small quantities needed for the bike paths, resulted in extremely high prices for the pavement. After the CM-GC made the case for the alteration, Oregon DOT was able to write a minor hot-mix asphalt specification that was more in line with what the local park agencies used on their bike path projects, meeting the needs of the project and its stakeholders at a reduced cost.

References

Molenaar, K., D. D. Gransberg, and D. N. Sillars. *NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction*, Transportation Research Board of the National Academies, Washington, D.C., 2015.

30 Real-Time Electronic Quality Management Information

Real-time electronic management of QM information—and other project documents—provides an organized system to record and access information.

What Is It?

Electronic management of the QM process can look very different, depending on the needs of the project and agency. At a minimum, such a system should allow for uploading and organizing daily reports for review and submission to the necessary team members. Some systems incorporate recording devices for inspectors to use in the field, which can then automatically upload checklists and inspection results. Other systems provide statistical analysis and decision tools, integrated databases, and administrative tools for use at an enterprise- or agencywide level. In addition, using a central location for all QC tests and a system to flag failed tests can be useful on large projects where noncomplying sections of work may not be fixed immediately.

Why Use It?

The benefits of an electronic data management system (EDMS) vary based on the scope of the system and the level that project participants utilize it. The primary benefit is organizing large volumes of information and providing a clear record of submission, receipt, and approval of everything from daily reports to QC tests performed by a third party. Additionally, it allows for quick retrieval of not only the submitted information but also the project plans and specifications related to QC.

The use of software—and some hardware devices—to manage QM provides several advantages. First, it organizes project documents in a centralized location for later reference. This is vital for large transportation or infrastructure projects where large volumes of information and reports are generated daily or weekly. Second, it provides users with access to information that they are authorized to view and alter via the Internet or intranet. Third, it tracks noncompliance issues and ensures that all areas of concern are followed up and closed out. Finally, the use of an electronic QM information system is customizable to the specific needs of a project.

Potential benefits include cost savings and schedule acceleration, as information is available when need and does not slow down the project.

Real-time electronic QM information addresses the Construction Quality Strategy and the Construction Efficiency Strategy. Quality standards are logged in and accessible. Quality tests are recorded and passes and fails quickly determined and communicated. Using one source for quality data enhances efficiency.

When to Use It?

The use of an EDMS becomes more valuable as project size increases. Projects spanning long time periods and large geographic distances can benefit from the organization and standardization provided by an EDMS. Smaller projects can also benefit, and can be setup to contribute information to a large database of information. The database becomes a resource for the agency to use in future decisions.

This tool is recommended for all size and complexities of projects, assuming that the system is already in place and available to the agency to use (Table A.33).

Table A.33. Recommended uses for real-time electronic quality management information.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
30 Real-Time Electronic Quality Management Information	✓					●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

The implementation of some form of electronic QM information system will require varying levels of commitment from an agency's staff, depending on the types of information to be captured and the level of functionality required. A simple system would provide a central location for depositing and organizing electronic files with varying levels of access for different project team members and may only exist for the life of the project. More complex, enterprise-level systems require the buy-in of agency upper management in procuring the necessary equipment and software development services, field inspectors to use the systems to their full potential, contractors and designers to use the system, and the agency as a whole to input project information into a database and to use that database of knowledge for future projects. The implementation success of the selected system will require continual user and system support to add, delete, train, and support users and to troubleshoot and customize features to meet the needs of the users. Deploying a system to the field in the form of handheld devices streamlines the inspection process and ensures that every item of work is checked so that any incomplete reports can be flagged for review. The agency should also ensure that the documents produced will be compatible with its permanent final records-retention protocols.

Synthesis of Examples

Some agencies create a management system when implementing a large, complex project and then have it available for future projects of any size. Agency staff need to be trained on the benefits and use of the system. The system must be used consistently and per the proper procedures. Inspectors must be equipped with appropriate handheld devices to use the system effectively.

Example

Portland Transit Mall Revitalization

The Portland Transit Mall Revitalization Project included the installation of a light rail line along the entire length of the Portland Transit Mall. Managed by TriMet transit agency, this CM-GC project used electronic collection and reporting of QC systems. This allowed the TriMet resident engineer to streamline the reporting process and provided easy access to a searchable database of reports for later reference that included field reports and laboratory testing results.

References

Jie, Y., C. Nan Fu, and G. W. Raba. Implementation of a Web-Based Electronic Data Management System for the Construction Material Quality Assurance Program of a Highway Mega-Project. Presented at 85th Annual Meeting of the Transportation Research Board, Washington, D.C., 2006.

Migliaccio, G. C., G. E. Gibson, and J. T. O'Connor. Procurement of Design–Build Services: Two-Phase Selection for Highway Projects. *Journal of Management in Engineering*, Vol. 25, No. 1, 2009. pp. 29–39.

Molenaar, K., D. D. Gransberg, and D. N. Sillars. *NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction*, Transportation Research Board of the National Academies, Washington, D.C., 2015.

31 Witness and Hold Points

During construction, there are certain stages—or points—when inspection, testing, and verification may need to take place. This work is done at critical points where specific aspects—such as checking technical quality requirements and safety requirements—have taken place so that the next activity or activities can proceed. These critical points during construction are called witness and hold points.

What Is It?

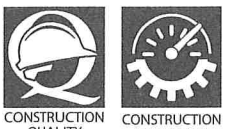
A hold point is linked to a specific construction activity. At the designated level of completion of the activity, a mandatory verification by the agency must occur before a process can proceed (Chung 1999). These are commonly assigned to critical construction features, such as work that cannot easily be inspected or corrected at a later stage because it will no longer be accessible (e.g., underground work). Agency verification may include final inspections or tests before further work is permitted.

A witness point is linked to the entire construction project; not a single construction activity. It is an identified point in the work process where the agency may review, witness, inspect, or undertake tests on any component, method, or process in the work being performed (Chung 1999). The presence of authorized agency personnel (i.e., the witness) is suggested during a witness point inspection or test. When a witness point arises, the contractor notifies the agency. The agency can choose to inspect or allow the succeeding activity to continue without inspection.

Why Use It?

Witness and hold points allow the agency to verify that the work is proceeding per plans and specifications before it is covered or enclosed (i.e., subsurface grading and prep for a paving project) and becomes inaccessible for inspection and testing.

Potential benefits include cost savings and improved schedule. This tool can save construction costs and schedule by preventing rework because errors can be detected and corrected early before additional work is placed over the inspected work.



Witness and hold points address the Construction Quality Strategy and the Construction Efficiency Strategy. Agreed-upon points serve as quality check points that either verify that work can proceed or that rework is necessary before impacting future work.

When to Use It?

During construction, the contractor is required to implement a QM plan that includes a witness and hold procedure. Then the agency and contractor agree to specific points where inspections and testing will occur during construction.

This tool is recommended for medium to large projects and moderately complex to complex projects (Table A.34). It can also be used with small, noncomplex projects if there are certain work items that would benefit from a quality check before succeeding work covers it up or locks it in.

How to Use It?

For witness and hold points to be effective, they have to be established before construction work begins. The agency and the contractor collaboratively create an inspection and testing

Table A.34. Recommended uses for witness and hold points.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	**Construction**	Closeout	**Noncomplex**	**Moderately Complex**	**Complex**	**≤ $10 million**	**$10 million–$50 million**	**> $50 million**
31 Witness and Hold Points				✓		◗	●	●	◗	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

procedure that both parties agree to use during construction. Once all specific points are identified, each has to be defined as either a witness point or a hold point. Points in construction where quality is critical are identified as hold points requiring agency permission before construction activities proceed. The remaining identified points are witness points where the agency is notified for an inspection, but agency permission to proceed is not required.

The contract must contain information about the agency's inspection and testing procedures and how the witness and hold point process works. The agency should provide information about inspections and tests, identification of points, and who is authorized to approve points (Chung 1999). The agency should clearly define requirements in an inspection and testing plan for the project so the contractor can work to meet those requirements.

Synthesis of Examples

On fast-track progress, the contractor may focus more on speed than quality. Witness and hold points are a tool that can help align project team members around quality goals. Witness and hold points serve as periodic reminders of quality goals. These points should be clearly defined prior to the start of construction and kept on the project schedule to make sure they are met.

Example

Winona Bridge Project, Minnesota Department of Transportation

The Minnesota Department of Transportation implemented witness and hold points during construction of the Winona Bridge. This was a complicated project involving rehabilitation of a historic steel bridge. The project was of significant public interest and concern. Multiple work packages to fast-track the project made ensuring quality even more important than usual.

On this project, the agency considered hold points essential. Hold points were a key driver in maintaining quality in materials and construction. Upper management communicated the high expectations for quality, which helped align all team members to this goal.

References

Chung, H. W. *Understanding Quality Assurance in Construction: A Practical Guide to ISO 9000.* E & FN Spon, London, UK, 1999

Gransberg, D. D., J. Datin, and K. Molenaar. *NCHRP Synthesis 376: Quality Assurance in Design–Build Projects.* Transportation Research Board of the National Academies, Washington, D.C., 2008, 130 pp.

Hoyle, D. *ISO 9000 Quality Systems Handbook: Using the Standards as a Framework for Business Improvement,* 6th Edition. Elsevier, Oxford, UK, 2009.

32 Payment Checklist

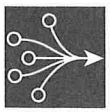
The payment checklist is a list of tasks related to payment for construction and specifies which payment tasks are performed by the contractor and which are performed by the agency.

What Is It?

The payment checklist helps guide invoice preparation and review. The checklist identifies contractor tasks, such as the invoice cover sheet, progress report, and schedule update. It also identifies agency tasks, such as quality verification, checking schedule, and checking for signatures on force account sheets. Each task may also have a reference to the section in the RFP that relates to that task.

Why Use It?

Potential benefits include accurate payment, good recordkeeping, and keeping the project on schedule by handling payment paperwork efficiently. When invoices are prepared completely to meet agency requirements, it helps ensure a smooth and timely review of invoices so that the contractor can get paid promptly. Furthermore, the payment checklist helps ensure all construction invoices are prepared and reviewed consistently. This can save time, since it is clear what the contractor needs to submit and what the agency needs to review.


ALIGNMENT


CONSTRUCTION EFFICIENCY

The payment checklist addresses the Alignment Strategy and the Construction Efficiency Strategy. The payment checklist aligns the agency and CM-GC on what is needed for invoice processing. This leads to construction efficiency, as the responsibilities of the people involved in the preparation and review of pay applications is clearly described. Time is not wasted in preparing what is not needed or having to redo the paperwork because something is missing.

When to Use It?

This tool can be used starting with construction and continuing through closeout (Table A.35). The payment checklist should be reviewed periodically and updated for accuracy. The payment checklist will only be effective if the information remains up to date. This tool is recommended for projects of all sizes and complexities and, therefore, should be standardized as an agency process.

Table A.35. Recommended uses for payment checklist.

	Contract Administration Phase					Project Complexity			Project Size		
	Alignment	Design	Preconstruction	Construction	Closeout	Noncomplex	Moderately Complex	Complex	≤ $10 million	$10 million–$50 million	> $50 million
32 Payment Checklist				✓	✓	●	●	●	●	●	●

Note: ● = Recommended; ◗ = Consider case by case; ○ = Not recommended.

How to Use It?

The checklist is created based on the agency requirements and the payment requirements included in the RFP. The contractor can use the checklist to check that all necessary elements are included in an invoice package. The agency uses the checklist as a guide to review invoices in a consistent manner.

Synthesis of Examples

The payment checklist should list the responsibilities of the CM-GC and the agency, as shown in Table A.36. An agency can modify this table to fully represent their payment checklist process.

Table A.36. Table template for payment checklist.

Payment Checklist	RFP Section	✓
Construction Manager–General Contractor		
Invoice cover sheet		
Progress report		
Contract schedule update		
Certification by construction QA manager		
Invoice data sheets and supporting documents		
Calculations and accounting documents		
Agency		
Verify and mutually agree on percentage of work complete.		
Check schedule against invoice amounts.		
Review monthly contract schedule updates.		
Check that force account sheets are signed.		
Check that all contracting officer requests are executed.		
Check materials per payment request.		
PE sign-off on CM-GC request percent.		
Complete comments form and transmit back to CM-GC.		
Notify CM-GC of invoice approval and amount to be paid.		
Distribute and save documentation.		

Example

I-405, NE 6th Street to I-5 Widening and Express Toll Lanes Project, Washington State Department of Transportation

Although this is a D-B project, the example payment checklist provides a useful template that can be used with CM-GC projects. In this project, Washington State DOT created a payment checklist to guide the contractor in preparing construction invoices and to guide Washington State DOT in reviewing contractor invoices. Tasks related to invoicing work include progress report, schedules, quality data, change order documentation, and signatures. To emphasize the importance of completing these tasks, references are made to the RFP sections where these tasks are mentioned.

C0000
Example Project
Example Address 12345

Estimate #: 10
Work Done Dates: 04/06/2017 to 05/05/2017
Estimate Payment Date: 05/17/2017

Payment Checklist

Payment Checklist	RFP Section	✓
Design-Builder		
Invoice Cover Sheet w/ signatures of the Design and Construction QA Managers	1-09.9(1).2	
Progress Report including narrative and technical report	1-09.9(1).2	
Contract Schedule update per 1-08.3(7) including .xer Primavera file verified to match the invoice	1-09.9(1).2	
Certification by Design and Construction QA Managers	1-09.9(1).2	
Invoice Data Sheets and Supporting Documents based on the price loaded Contract schedule	1-09.9(1).2	
Design Exception Report	1-09.9(1).2	
Incentive Self-Assessment	1-08.11(1).1	
If HMA adjustment requested, **Calculations and Accounting documents** required to be submitted	1-09.9(2).1	
WSDOT		
QV – verify and mutually agree with D-B on physical percentage of Work completed		
Check Schedule against Invoice amounts incl. Paid TTD; Paid this Period; Previous		
Review Monthly Contract Schedule Updates	1-08.3(7)	
Check to ensure Force Account sheets are signed		
Check to ensure all CO requested are executed		
QV – check materials per D-B payment request		
Input into CAPS and print Pre-Estimate for PE signature		
PE signed off on DB requested %		
Complete WSDOT comments form and transmit back to Design-Builder		
Advise D-B that payment is approved and total amount to be paid		
Once payment is made, email all information to Document Control for distribution		

Signed by:
Print name:
Date:

APPENDIX B

Case Studies

Table B.1. Construction manager–general contractor case studies.

Case Study No.	Agency	Project Name	Primary Facility Type	Project Type	Dollar Value (millions)	Start Date
CM-GC $10 million to $50 million						
1	Colorado DOT	I-70 Vail Underpass	Road, Bridge	New Construction/ Expansion	$18	Oct 2015
2	Colorado DOT	US 6 & 19th Interchange	Road, Bridge, Drainage	New Construction/ Expansion	$21	Feb 2016
3	Colorado DOT	I-25 / Arapahoe CM–GC	Road, Bridge, Drainage, ITS	Rehabilitation/ Reconstruction	$50	Apr 2016
4	FHWA–CFLHD	South Fork Smith River Road	Bridge	Rehabilitation/ Reconstruction	$11	May 2015
5	Utah DOT	SR-108; SR-127 to SR-107	Road	Reconstruction/ Expansion	$50	Mar 2017
6	Caltrans	I-215/Barton Road Interchange	Road, Bridge	Reconstruction	$47.5	Nov 2017
CM-GC >$50 million						
7	Minnesota DOT	Winona Bridge	Bridge	New Construction/ Reconstruction	$170	Jul 2014
8	Colorado DOT	SH 82 Grand Avenue Bridge	Road, Bridge	New Construction/ Expansion	$75	Jan 2016
9	Minnesota DOT	TH 53	Road, Bridge	New Construction/ Expansion	$153	Sep 2015
10	Colorado DOT	E-470 Widening: Parker to Quincy	Road, Bridge, Drainage	New Construction/ Expansion	$75	May 2016
11	Arizona DOT	I-10 and Ina Road Traffic Interchange	Road, Bridge, Drainage	Reconstruction/ Expansion	$124	Jun 2016

Note: ITS = Intelligent Transportation System.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S. DOT	United States Department of Transportation

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